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THE UNIVERSITY OF ALBERTA

WORK ORGANIZATIONS AS SELF-ORGANIZING SYSTEMS

by

KENNETH STEPHEN MEEN

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF Doctor of Philosopy

IN

Counselling Psychology

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ABSTRACT

The significance of recent theoretical developments regarding self-organization in living systems to work organizations is explicated. These developments are reviewed in the relevant works of Gregory Bateson, Heinz von Foerster, Umberto Maturana and Francisco Varela. Autopoiesis, radical constructivism, second-order cybernetics, and the production of autonomous stability in organizationally closed systems through recursive processes are reviewed. The nature of language and explanation are explained including their epistemological and ontogenic consequences. Conditions underlying pathology in systems are explicated in terms of the epistemological status of the observer.

The inquiry into the significance of these concepts in the context of work organizations is initiated by developing a description of work organizations as social systems and autopoietic systems whereby they are defined in terms of the processes that realize them. The implications of a second-order cybernetic epistemology are then explored in reference to theoretical domains and to ontogenesis, which describes the recursive relationship between observer distinctions and conditions which are brought forth in organizations. First- and second-order cybernetic explanations are distinguished and seen to describe different notions of coherence. It is explained

how the latter allows a logical accounting between the domains of operation and semantic explanation.

The epistemological conditions leading to pathology are explored in the context of a traditional, hierarchically defined organizational coherence based on notions of instructive interaction and trivialization. Deficient explanations are seen to create deficient systems. Conversely, it is argued that systems brought forth through distinctions of self-organization would describe the processes of self-organization which allow the organization to conserve adaptation. Several issues which contribute to the model of coherence through processes of self-organization are delineated. Sociotechnical Systems are discussed as an example of how an organization characterized as self-organizing might function, even though the coherence between the observer and his invented reality is not part of Sociotechnical Systems theory.

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I. INTRODUCTION

A New Paradigm: Models of Life

A new paradigm of living-systems has emerged, spawned by the conceptual innovations of contributors from several theoretical disciplines. One of the first elements of the new paradigm was the development of cybernetics. The mathematician, Norbert Wiener (1954), identified the conceptual shift that preceded the birth of cybernetics: Newtonian determinism was replaced with an incomplete determinism, borne of the probablistic thinking of Gibbs and the relativistic notions of Einstein, thereby acknowledging chance and uncertainty in the world. Wiener's book, Cybernetics (1948), developed the contingent view of the physical world and in his following book, The human use of human beings (1954), the concepts of communication and control in society were proffered. In this work Wiener held that the theory of control applied equally to man and machine. It is with Wiener that terms such as equilibrium, input, output, feedback, information, control, and entropy in the context of systems were operationalized. Principles of cybernetics and the closely related General System Theory of Von Bertalanffy were broadly applied to several disciplines and became established as separate sciences in their own right.

Historically, the body of literature on organizational or adminstrative science has been focussed

on the problem of integrating and coordinating technology and the efforts and activities of people to bring about "organization". For example, Frederick Taylor's "scientific management" sought to maximally specify and control workers' activities to increase production efficiency. Max Weber's theory of bureaucracy focussed on the conscious organization of people and activities in service of the purpose of the organization, and introduced conceptual distinctions such as hierarchy of authority, rules, and specialization (Ulrich and Wieland, 1980). While behavioral neurophysiology was the first discipline to be heavily influenced by cybernetics (von Foerster, personal communication), the social sciences and administrative/organizational sciences were soon to follow.

The concepts of cybernetics bear strong connotative similarity to the coordination and integration within work organizations. Wiener saw these notions of communication and control as critical to negating entropy or disorganization (1954). Stafford Beer, the prominent purveyor of cybernetics applications in work organizations, indicates that cybernetics is the science of control, and thus significantly contributes to management, which is the profession of control. As such, Beer defines cybernetics as the science of effective organization (1981). Cybernetics spawned Von Bertalanffy's "General Systems Theory" which is often

cited in reference to the "open systems model" in the organizational literature. This theory refers "both to a complex of interdependencies between parts, components, and processes that involves discernable regularities of relationships, and to a similar type of interdependency between such a complex and its surrounding environments" (Evered, 1980). Such systems are said to be "open in the sense that there is a "throughput of material and energy" (Boulding, 1956). That is, they are thermodynamically open.

Perhaps the clearest and most cited translation of General Systems Theory into terms specific to work organizations is offered by Katz and Kahn (1978), who indicate that open systems thinking has two notable advantages. First, that the dependence of the organization of the environment receives due emphasis, and second, that processes of feedback upon which the survival of the organization depends are understood and developed. Other writers have identified other advantages such as the identification of various elements of a system and the recognition of interdependence, both among support structures and organizational components. This approach offered the same benefit to theories of work organization that it did when applied to other subjects: highly complex phenomena became explainable.

However, while the open systems approach continues to predominate in the literature, it has been criticized as

insufficient to explain the behavior of organizations. While notions of feedback, information, homeostasis, and so on are often operationalized to describe an intentional coordination and integration of activities around a purpose through devices such as priority setting, setting of routines, timing and synchronizing functions, and scheduling and sequencing events (Katz & Kahn, 1978), what begins as a rational, purpose-directed effort typically results in disorder and unpredictability (Weick, 1979), and thus is not at all well explained by this approach. This view is also held by Ullrich and Wieland (1980) who indicate that the systems approach does not adequately explain the failure of individuals to follow rational plans and that a comprehensive view must account for actions of individuals that are sometimes conflicting and unrelated. Evered (1980) believes that systems thinking has been more successfully applied to the technology of organizations rather than the social domain of which we are only beginning to grasp the complexities and subtleties. Furthermore, the application of rational systems-control engineering to the human side of the organization could have seriously deleterious consequences. Weick (1979) suggests that open systems models can divert our focus from what occurs inside organizations that is crucial to the persistence of the organization: it provides the wrong analytical base.

The antithesis of rational systems explanations is perhaps represented in the distinctions of the "symbolists". The theoretic development of the notion of symbolism in organizations points to a new dimension of organizational phenomena, recognizing that organizational members' ability to use language, exhibit insight, produce and interpret metaphors and vest meaning in events, behavior and objects are symbolic acts that are essential aspects of organizations (Morgan, Frost, and Pondy, 1983). Thus the "symbolists" assert that models of organization based on mechanical and organismic metaphors fail to consider complex patterns of human activity by limiting the focus purely to rational aspects. From this perspective, rational design is not capable of bringing about organizational cohesion (Golembiewski, 1986). Commonly cited processes in the Organizational Behavior literature, such as job design, performance management systems, leadership, management development, decision making, planning and so on, that are assumed to bring about the rational integration and coordination of activities and technologies in service of an organization's mission, would be considered insufficient explanations to the extent that the symbolic dimension is not considered. Daft (1983) has defined the "rational" part of the organization as the striving for logic and order, based on the assumption of stability and predictability and the calling for routinization, as

opposed to the "social" system which must deal with the reality of chaos and disorder. Explanations exclusively based on the former will apparently not account for organizational cohesion.

Thus, while the open system model is certainly more elaborate than earlier models with an obvious mechanistic and rationalistic flavor, it represents the quintessential rational model, and says little about the subtleties and complexities of the world of humans in organizations. Perhaps the oft lamented weak relationship between organization theory and the practice of organization development (O.D.) is one result of this. According to Peter Vaill (in press), O.D. can be characterized as a process for understanding and improving substantive organizational processes such as planning, group meetings, superior-subordinate communications, and so on. The more that is known about how these processes are upset, the more successful O.D. efforts will be at identifying processes for improving them. Vaill believes that current O.D. processes do not adequately deal with the processes whereby the nature of the organization is understood by its members; we need better ways of understanding language and consciousness, thinking processes, and competing definitions of reality.

The study of the dynamics of social and biological systems has led to distinctions which are beyond those initially characterizing simple cybernetics and General

Systems Theory, namely distinctions related to self-organization. Jantsch (1980) describes the new understanding as "process oriented," meaning that a system "appears as a set of coherent, evolving, interactive processes which temporarily manifest in globally stable structures that have nothing to do with the equilibrium and the solidity of technological structures" (p. 6). Self-organizing systems have several general characteristics (Capra, 1982). Their structure and function are self-created rather than imposed by the environment; their organization is self-determined even though they continually interact with their environment; they are self-renewing in the sense that the integrity of their overall structure is maintained while their components are continuously renewed and recycled.

The principles of self-organization appear to be universally applicable across a broad range of phenomena; the dynamics of precellular to socio-cultural systems alike have been elucidated. Jantsch (1980) indicated that this orientation toward "models of life" out of the study of natural systems has established a common thematic link between biological and social systems whereby the latter is grounded in the former. The significant implication of this is stated by Dell (1985) as "social systems and all human endeavor must be understood in light of our existence as biological entities that are coupled to a medium" (p. 1). In effect, the explication of this

apparently simple idea fundamentally reframes many current beliefs about living systems, ultimately questioning several basic tenets and principles such as: the hierarchic organization of systems including notions of subordinacy and superordinacy, the whole notion of information-feedback-control including the actual existence of information, the concept of openness to the environment, objectivity, purpose, and so on.

"Models of life" offer the possibility of exploring the implications of viewing organizations in light of our existence as biological entities coupled to a medium. The dynamics of organization can be considered from a perspective of operational closure, bringing forth a different understanding about what occurs inside organizations that is crucial to their persistence. In fact the processes inherent in our theorizing about organizations themselves belong to the class of "models of life" and, as members of this class, exemplify similar processes embedded in the phenomena of work organizations. That is, the nature of the systems themselves is inextricably intertwined with our way of understanding them. This new perspective speaks to notions of "rationality"; all "rational" distinctions are embedded in living systems. Thus while Daft (1983) suggests that we balance rational and social forces in organizations, in fact we are peremptorily guided to conceive of rationalistic distinctions as a subset of living systems;

they are a consequence of a distinction, made by a living system that can be understood if we emulate Bateson (1979), who put aside the pleroma, "where forces and impacts provide sufficient basis of explanation," and focussed on the creatura, the world of the living "where nothing can be understood until distinctions and differences are invoked" (p. 8).

It is probably a safe assertion that explanations based on both pleroma and creatura have appropriate application in organizations. It is doubtful that, for example, the technology in organizations would be usefully explained as creatura. The determination of which phenomena would be appropriately explained as creatura, however, is certain to be much more complicated. While it would appear that we can easily conclude that the social domain is obviously part of the world of the living, the implications of this assertion to a more microscopic view of particular constructs and processes are potentially byzantine. Consternation would likely characterize the response of many to the assertion that cybernetic terms like information and control do not constitute processes in living systems. It is probable that the unstated theories and assumptions held by organizational members that form the basis of the design and operation of organizations are rife with distinctions of the class of pleroma in the domain of creatura. When it is assumed that people will behave according to the stated plan it is

no doubt often vexing when they don't. Unraveling the relationship between creatura and pleroma would mean determining which phenomena are best explained with which terms so that we could avoid applying the language of pleroma to the world of the living.

Certainly within the organizational literature it is not difficult to find an issue about which consensus does not exist, even among those using similar terminology. Refering to General Systems Theory and Organizational Development, Connolly and Pondy (1980) indicate that neither "is a well-developed, tightly integrated body of knowledge and technique. Rather each represents a loosely articulated set of diverse theory and practice, with adherents trained in a wide range of disciplines, oriented to a wide range of methods, and attacking a wide range of problems" (p. 15). There is limited reference in the contemporary literature to the new living systems paradigm, that, when coupled with the diversity in knowledge and technique, leaves us with few parallels to stimulate a discussion of the cross-mapping of the two. Yet the organizational literature no doubt contains many examples of discourse which, upon examination, would reveal congruency with these notions. For example, Peter Vaill (1985) wrote an article entitled "Process Wisdom for a New Age" in which the limitations of reductionism and objectivistic science are well explicated and the notions of patterns, ambiguities, consciousness and relational

thinking are championed in truly eloquent fashion. However, given the breadth of the literature and the overwhelming number of concepts contained therein, a comprehensive examination and cross-mapping would be a task of formidable magnitude. Thus we are led into a discussion of a more exploratory nature in which fundamental relationships and meanings are considered. They may have relevance to any of the diverse knowledge extant in the organizational literature. Golembiewski (1986) has identified "prominences of progress and stuckness in organizational analysis and praxis". Furthering our understanding of organizations as living systems ought to attenuate prominences of stuckness and add to prominences of progress.

The development of the theory of living systems has resulted in effulgent ideas that might be seen as a change of paradigm in the Kuhnian sense, i.e., a shift in the "model problems and solutions to a community of practitioners" (Kuhn, 1970, p.viii), notwithstanding the current paucity of published discourse dealing with the specific application of these ideas to organizational phenomena. In the domains in which living systems theory has been developed, fundamental questions of ontology and epistemology have usually arisen. These questions and concepts can be considered in the context of work organizations to enable us to contemplate their import to the question of the relationship between pleroma and

creatura, and their implication for the ontogenesis of organizations. The organization of living systems is a fundamental issue which ultimately underlies many questions about the functioning of work organizations.

The major thrust of this exploration begins as a seedling idea stated very broadly; that living systems have something to say about the organization of organizations. Of course patterns in organizations can be distinguished at many levels of analysis from the individual to the work group in the organizational context to the organization in the context of the environment. What is said at each of these levels of analysis depends on the particular living systems notions brought forth as well as the writer's ideographic interpretations. Of particular interest here, and of seemingly significant relevance to the consideration of the organization of organizations are living systems notions which deal with the way in which an observer creates reality through operations of closure, and as such participates in the production of a social reality which the observer calls the organization. The process of bringing forth a reality and the role of language in the coordination of action among observers are fundamental principles whose implications are of key interest to this discussion.

Much of the recent development of the epistemology and ontology of living systems can be largely attributed to Gregory Bateson, Heinz von Foerster, Umberto Maturana

and Francesco Varela, all of whom have entertained a variety of possible applications of their notions to different domains. Being concerned with similar theoretical territories, it is not surprising that these individuals have been associated with each other: Bateson and von Foerster dating back to the earlier work on cybernetics with Norbert Wiener, von Foerster and Maturana as colleagues at the Biological Computer Laboratory of the University of Illinois, and Bateson, near the end of his life, identifying Maturana as the torch bearer. The interaction between these individuals has likely contributed to the wealth of ideas created. The intent of this exploration is to begin to transcribe many of the complex notions which were put forth by these individuals into terms useful in the context of work organizations. The psychopathology/therapy domain has received similar attention and, in connection with other writers, has unfolded a well subscribed set of applications. Where these are of interest to the current discussion, they will be drawn upon. Yet it is anticipated that significant differences exist between family systems and organizational systems in spite of the fact that in both systems the role of the observer in creating a reality through language is fundamental. While the role of this fundamental process operates in both kinds of systems, conversations about system coherence differ between the two. Organizations are often distinguished at more levels

of analysis, and conversations of coherence reflect these. The relationships between these levels add to the complexity of the operation of the system, expanding the possibilities for dysfunctional interactions and complicating the bringing forth of coherence among parts of the system.

II. THEORETIC CONSIDERATIONS

The following section presents the major ideas of Bateson, Von Foerster, Maturana and Varela. This overview of relevant highlights of these authors' work is not intended to be comprehensive. To accomplish that task would be formidable as the ideas of each one alone are known as highly complicated and difficult to understand. Wilder-Mott (1981), in reference to Bateson, indicated that his ideas are complex and vexing "taken even singley, and more baffling yet when taken as a whole" (p. 33). The same is most certainly true of von Foerster, and Maturana and Varela. The reader is referred to their original works for detailed treatment. Thus the review of these writers emphasizes neither a systematic accounting of their broad works, nor their evaluation and comparison. Rather certain of their concepts raise interesting questions and provide interesting answers about the organization of organizations in an apparently novel way, expanding the possibilities regarding the characterization of work organizations.

Gregory Bateson

From the perspective of the audience, Bateson's work can be seen as a precursor to Maturana and Varela's work, even though they proceeded along relatively independent paths of development. In other respects, Bateson provides distinctions which are timelessly erudite. His work covers over fifty years during which he was continually

reinterpreting and changing his language. He first mapped his concepts in terms of cybernetics, then an expansion of Russell and Whitehead's Theory of Logical Types, and last in terms of "mind" as discussed in Mind and Nature (Bochner, 1981). Many of Bateson's distinctions may seem rudimentary in comparison to developments since his death, but by and large are still practicable. His thinking involves the pursuit of patterns of thinking about thinking, a preference for hierarchies of description and explanation, and a preference for deduction over induction. Wilder-Mott (1981) indirectly credits Bateson for deriving the interactional view of human communication. Keeney (1983) would apply the term "cybernetic epistomologist" to those contemporary theorists whose notions are the ideologic beneficiaries of Bateson's thinking.

As an anthropologist, Bateson put forth the notion of schismogenesis (complementarity and symmetry), a formulation which contained early reference to the interactional view, circular causality, and paradox. His anthropological field-work style of investigation apparently persisted throughout his life; he would patiently observe patterns and carefully record them. Through his anthropological observations Bateson was impressed with man as a creature who learns, and thus Bateson rejected the role of instinct. He identified the importance that punctuation has on the interpretation of a

sequence of events, and applied this insight to a running critique of learning theories and a subsequent elaboration of his own theories of learning. After World War II Bateson began developing an interest in cybernetics, which at that time was pretty much limited in application to the study of control of mechanical and physiological systems. Bateson immediately saw the applicability to the study of human interaction and invested considerable energy on the topic. Cybernetics seemed to parallel Bateson's way of thinking and provided him with a whole new language with which to conceptualize social systems. It seemed to allow a more unified and sophisticated explanation of many of his previous theoretical formulations.

Bateson began working on a study of communication among psychiatrists under Jurgen Ruesch in the late 1940's. This furthered the application of cybernetics to human communication and generated a paper in which the cybernetic model was introduced to behavioral scientists (Lipset, 1980). Soon thereafter Bateson began working on Russell's Theory of Logical Types, which dealt with hierarchies of classes. These hierarchies were applied to communication and the term "metacommunication" was born, together with thoughts on various relationships between different levels of communication. Weakland (1981) indicates that a major theme emerged from this research: "a clearer idea that we were talking about a new epistemology based on interaction - a circular, cybernetic

rather than a linear model of causality (p. 54). The following discussion briefly outlines some major themes of interest to this discussion.

Schismogenesis, Complementarity, Symmetry, Interaction

Bateson's attention was given to the "process and dynamics of social equilibrium" (Lipset, 1980, p. 143), and thus he showed his predilection to deal with interaction. The notion of schismogenesis and its two subcategories, complementarity and symmetry, required an appreciation that A's reaction to B's behavior will affect B's later behavior, which will then affect A. In a complementary pattern "the dominant person in an interacting pair will become more assertive while the submissive one becomes more passive. The submission enhances the dominance and the enhanced dominance encourages more submission" (Lipset, 1980, p. 144). Other complementary patterns include exhibitionism-spectatorship, feebleness-succorance, master-apprentice, and so on. In symmetrical patterns both parties behave in a similar fashion, as in boasting. "A position is set up in which the behavior XYZ is the standard reply to XYZ" (Bateson, 1972, p. 68). Bateson used the term progressive differentiation to describe an escalation in either pattern, although the term "vicious circle" was later used. "Schismogenesis" roughly equates with "vicious circle". His systemic thinking is further revealed in his term "restraining factors" which relates to those factors

which restrain both types of schismogenesis and thereby maintain equilibrium in the system (Bateson, 1972). After Bateson became interested in cybernetics he changed the term "schismogenesis" to "regenerative feedback". Implicit in the above notions is a view of behavior in interactional rather than intrapsychic terms.

Context and Punctuation

Bateson defined "context" as "pattern through time" (Bateson, 1979, p. 14). Before we can have meaning we must have context, and the meaning of an "action or sound changes relative to context" (Bateson, 1979, p. 115). This notion is related to the idea of messages, the meaning of which depends partially on context. Bateson indicates that the context in which learning takes place influences the view of both the experimenter or onlooker. The context of the experimenter determines whether he sees a S-R sequence as operant or classical conditioning; this depends on where he punctuates the sequence. Context and punctuation can create entirely different perceptions of an event. Bateson writes, for example, that characteristics do not reside within people, but rather are dependent on the transactions between the individual and his material and human environment (context). The notions of context and punctuation appear throughout Bateson's work, somtimes explicitly and sometimes not. They are embedded in the concept and processes of interactionism.

Cybernetics

At the time of Bateson's developing interest in cybernetics, Norbert Wiener was the chief exponent. Bateson saw cybernetics as a potential unifying structure and was largely responsible for its application to social systems. Cybernetic loops, as self-corrective circuits, were able to express concepts consistent with notions of homeostasis and the maintenance of stability in systems. A cybernetic circuit is a system of communication in which feedback maintains a steady state. Positive feedback is offset by negative feedback. The message that is carried around the circuit is one of difference, i.e. the difference between a predetermined state and the current operating state of the system. This quality of cybernetic systems led to Bateson's remark regarding the importance of difference in communication systems: it is the difference between messages that leads to response, or messages depend upon differences which make differences (Bateson, 1972). If positive feedback is met with positive feedback, a process called regenerative feedback occurs in which self-destruction (entropy) occurs.

Cybernetics, as a study of the relations rather than actual content (metalevel vs. level), became the framework within which the nature of information and communication was explained. Bateson implemented and expanded the notion of codification, "or the transformation of events in the world into symbolic information" (Lipset, 1980, p.

188). Digital codification represented the content of language, which does not resemble that for which it stands. Non-verbal codification, such as gesture and tone, conveys relational aspects of the communicators, and is termed analogic. Digital and analogic messages are frequently exchanged simultaneously (Lipset, 1980). The relations between analogic and digital messages were viewed from a hierarchy of classes following Whitehead and Russell's Theory of Logical Types.

Communication and Logical Types

Briefly, the Theory of Logical Types describes hierarchies of classes, in which a discontinuity exists between a class and its members. When the discontinuity is violated a paradox can occur. "Corresponding to [a] hierarchy of names, classes, and classes of classes, there is also a hierarchy of propositions and messages, and within this latter hierarchy the Russellian discontinuity between types must also obtain. We speak of messages, metamessages and meta-meta-messages" (Lipset, 1980, p. 190). Metacommunication usually remains implicit and conveys information about the relationship between the speakers. Metacommunicative messages of friendship or hostility may occur in the context of a (for example) psychiatric interview, which itself raises questions of how the metacommunications should be interpreted (Bateson, 1972). Thus the context, in this case, has the effect of meta-meta-communication. At a metalevel communication is

compelled. Incongruity between digital and analogic messages can lead to humor, play, therapy, and pathology.

Epistemology

Bateson was interested in "patterns that connect", and for him a consideration of form and process was absolutely essential. He went beyond first order patterns to explicate second order patterns and so on. This leads to his affinity with seeing things in terms of hierarchies of class and relationships between them (Wilder-Mott, 1981). In Mind and nature Bateson shifts from hierarchy of class to "hierarchy of orders of recursiveness," no doubt reflecting the later influence of cybernetics. This nonlineal view focuses on "interrelation, complexity and context" (Keeney, 1983, p. 14). Bateson preferred deduction to induction, believing that most contributions of significance were generated by the former. Indeed this preference was consistent with thinking in cybernetic terms.

To Bateson, cybernetics was "the biggest bite out of the fruit of the Tree of Knowledge that mankind has taken in the last 2000 years" (Bateson, 1972, p. 478). In the course of his life cybernetic explanation became an integral part of his concept of "mind". Recursiveness means that "we perceive only the products of our perceptions" (Bateson, 1977, cited in Bochner, 1981), and shifts the focus of explanation to form; "in recursive systems it is 'transforms' - distinctions, differences,

representations - that are essential to explanation. A human response is a creation resulting from an internal representation that the person himself participates in (Bochner, 1981, p. 74)." Thus it follows that an explanation based on the internal representation is itself an internal map of the stimuli, and the explanation itself is recursive, in that it becomes that which has to be explained. This means that there are no truly raw data, as every map has been subject to transformation. The processes of relating the recursive connection, to Bateson, led to the importance of conceptualizing Mind as a necessary explanatory principle. "It is recursive, embodied in its own output; that is the various representations it produces: ideas. Mind is the pattern which connects" (Bochner, 1981, p. 74).

In Mind and nature, Bateson lists six criteria, which, if satisfied, would qualify any system as a Mind. These ideas are central to Bateson's point of view. Firstly, he states that "A MIND IS AN AGGREGATE OF INTERACTING PARTS OR COMPONENTS" (p. 92). This means that "the theory of mind is holistic and . . . is premised upon the differentiation and interaction of parts" (p. 94). Secondly, "THE INTERACTION BETWEEN PARTS OF MIND IS TRIGGERED BY DIFFERENCE." While the cause of an event can be due to the force of one part on another in a material system, this is not so when dealing with ideas. The latter case requires a relationship between two parts and

a receiver which responds to a "difference or a change." Further, difference exists only within the context of the relationship between the parts, and "is not located in time or in space." Thirdly, "MENTAL PROCESS REQUIRES COLLATERAL ENERGY." This means that since "difference" does not contain energy, and any process (including mental) requires energy, the energy must come from the interacting parts. Fourthly, "MENTAL PROCESS REQUIRES CIRCULAR (OR MORE COMPLEX) CHAINS OF DETERMINISM." This criterion refers rather directly to cybernetic explanation, including its terms and implications. Fifthly, IN MENTAL PROCESS, THE EFFECTS OF DIFFERENCE ARE TO BE REGARDED AS TRANSFORMS (i.e., CODED VERSIONS) OF THE DIFFERENCE WHICH PRECEDED THEM." The meaning of this statement is approached metaphorically by the statement: "the map is not the territory." Bateson posits that this statement can be stated in more general terms: "the effect is not the cause." Further, "the fact of difference between effect and cause, when both are incorporated into an appropriately flexible system - is the primary premise of what we call transformation or coding." The various relationships between cause and effect can be classified into patterns. Sixthly, "THE DESCRIPTION AND CLASSIFICATION OF THESE PROCESSES OF TRANSFORMATION DISCLOSES A HIERARCHY OF LOGICAL TYPES IMMANENT IN THE PHENOMENA." This point emanates from Russell's Theory of Logical Types, which deals with

classes and their interrelations. A simple coding occurs in one class, but gives rise to a message in another class of information. The latter message is of a different logical type from the former, and is referred to as a metamessage. Further, the meaning of a message depends on context.

Heinz von Foerster

Von Foerster's intellectual career follows a progression from traditional physics through cybernetics to the operation of self-organizing systems. Varela (1984) writes that as an original member of the Macy Conferences which spawned cybernetics, he grew "from a physicist into a cybernetician by inventing what it is to be one" (p. xiv). In subsequent studies of cognition von Foerster progressed to the notion that cognition and cogniser are inextricably bound up as expressed through recursive processes. Consequently the epistemology of the observer became an important consideration in self-organizing systems, a notion highly consistent with Bateson's statement that we perceive only the products of our perceptions. Von Foerster's constructivist ideas offer a different set of terms and explanations relating to a similar phenomenal domain. The discussion of these distinctions begins with a list of von Foerster's aphorisms which were collected by Varela (1984) and offered as "scientific koans":

*First order cybernetics: the cybernetics of observed systems;

Second order cybernetics: the cybernetics of observing systems.

*The nervous system is organized (or it organizes itself) so as to compute a stable reality.

*There are no primary sensory modalities.

*Cognition:---->computations of---┐
↑_____________┘

*Objects: tokens for eigen behavior.

*The logic of the world is the logic of descriptions of the world.

*Necessity arises from the ability to make infallible deductions;

Chance arises from the ability to make infallible inductions.

*Objectivity: the properties of the observer shall not enter in the description of his observations.

Post-objectivity: the description of observations shall reveal the properties of the observer.

*A is better off when B is better off.

*If you want to see, learn how to act.

These postulates contain the essence of the implications of von Foerster's constructivist epistemology, which begins with a consideration of the recursive closure of cognitive processes (p. xviii).

A statement of the biological basis of von Foerster's position is contained in a paper entitled "On constructing

a reality" (1973), in which he describes the neurophysiological process of perception and some of its basic implications. Von Foerster achieves this first through the demonstration of an experiment in which the observer is made cognizant of the "blind spot" in visual perception due to the location of the fovea on the retina. Of particular interest is that we all have this interruption of our visual field (blind spot), but are not aware of it. Thus we do not perceive that we do not perceive. Von Foerster briefly presents a clinical case demonstrating that occipital lesions in the brain resulting in a loss of part of the visual field are not perceptable to the patient, another example of "absence of perception of absence of perception". Another experiment shows that certain words change into other meaningful words upon repetition. Yet another experiment demonstrates that a cat hears what he comprehends but did not hear the same stimulus prior to comprehension. The point of these experiments is to demonstrate that we can "see or hear what is not 'there'", or we can fail to "see or hear what is 'there' unless coordination of sensation and movement allows us to 'grasp' what appears to be there" or, in other words, the physical nature of the stimulus is not encoded in the response of a nerve cell (von Foerster, 1984, p. 45). If this is the case then, von Foerster asks, "how does our brain conjure up the tremendous variety of this colorful world as we experience

it at any moment while awake, and sometimes in dreams while asleep", that is, how do we understand cognition? The answer, suggests von Foerster, is that cognitive processes can be interpreted as "never-ending" recursive processes of computation.

Support for this interpretation has a neurophysiological basis. While a detailed account of von Foerster's line of thought will not be offered here, the rudiments of his reasoning are not complex. The complexity of the neural network between sensory and motor units introduces a "computational element" which results in an "astounding latitude" in the organism's behavior. Many computational possibilities exist as a result of the many possible variations of "inhibitory" and "facilitory effects" operating in the neural network. These effects give rise to an internal environment which is grossly more sensitive to internal changes than the sensory receptors are to the external environment. This highly complex internal neural network, which is sensitive to internal changes,"computes all perceptual, intellectual, and emotional experiences". A double closure exists in the functioning of the nervous system. The first closure occurs in the relationship between the motor surface (MS) and the sensory surface (SS), where impulses from the SS "act on the MS whose changes (movements) are immediately sensed by the sensory surface." The second closure involves the neuropituitary affecting the way the system

operates, so that the system also operates on its own operators. Consequently, "The nervous system is organized (or organizes itself) so that it computes a stable reality", and hence "regulates its own regulation" (p. 59).

Therefore, von Foerster demonstrates that cognition is fundamentally a process of computing a reality in the recursive operation of a closed system. Varela (1984) distinguishes two fundamental principles in von Foerster's work that are present in the previous discussion. The first refers to the "internal coherence" of a cognizing system; the second refers to the understanding that similar processes are involved in our own knowledge. According to Varela

> These two levels are inextricably connected: the study of mechanisms proper of first order systems (those we study), and the study of how second-order systems (those we are) are reflected in such descriptions. This mutually specifying pair, and all its details, constitutes the space where cognition is to be properly understood. (p. xiii)

To study the mechanisms proper of first order systems (the observed system) is to take a first order cybernetic perspective in the delineation of recursive processes that take place at that level of analysis. The study of observing systems rather than observed systems has been labelled cybernetics of cybernetics or second order

cybernetics. The characteristics of the observer become part of the observed system, recognizing the recursive relationship between observer and distinction. This occurs in spite of the fact that the observer typically has no experience of constructing a reality, i.e. we are blind to our own closure.

Von Foerster (1971) indicates that the root of the cognitive problem is both epistemological and computational. The epistemological component refers to the circular closure of cognition and ultimately the assertion of constructivism which leads to the conclusion that objectivity is a myth. Second order cybernetics is an epistemological formulation. "Computation" refers to the operation of the complex neural network which computes a stable reality, but is also extended to computation "in the semantic domain". Von Foerster (1971) indicates that " the structure of semantic relationships which is embodied in the functional and anatomical organization of our brains, and which makes us respond to and interact with others through language and behavior, is only now being explored and slowly understood" (p. 217). Von Foerster has extended several themes related to the implications of epistemological and computational aspects of cognition. Segal's (1986) compendium of von Foerster's work presents many of these themes in comprehendable summary form. It contains material from lecture notes and presentations that are not readily available elsewhere and

therefore is a major source of the following discussion. Segal's organization of von Foerster's ideas is also occasionally used.

Trivialization

Von Foerster (1972a) has distinguished a trivial machine from a non-trivial machine, where a machine is defined as "well-defined functional properties of an abstract entity" (p. 201). The former is a deterministic system because a one-to-one relationship exists between its input and output (or cause and effect), and a predictable system because the same input leads to the same output on different occasions, independent of historical events. Thus a trivial machine is also analytically determinable. A non-trivial machine's output, however, is determined by the previous output; its present relations are determined by previous steps. Thus they are deterministic, but history dependent and unpredictable since the same input will not result in the same output on different occasions. If these machines are seen to have internal states, the trivial machine has only one which always operates, while the non-trivial machine shifts from one state to another. Ergo, the non-trivial machine is analytically indeterminable and elusive.

The machines that we produce are hopefully trivial, in the sense that we want to control their behavior (e.g. a toaster should toast). Von Foerster suggests that all

of our efforts are directed at producing trivial machines, but that we suffer as a result:

> While our pre-occupation with the trivialization of our environment may be in one domain useful and constructive, in another domain it is useless and destructive. Trivialization is a dangerous panacea when man applies it to himself... (von Foerster, 1972a, p. 202)

Von Foerster indicates that higher mental faculties associated with cognition (memory, perception, and learning) have come to be viewed as "functional isomorphs" of the machine operations that were used to explain them and consequently have become mechanized and trivialized. When treated as separate functions in isolation from cognition, "memory" is reduced to "recording", "learning" to "change", and "perception" to "input", and the totality of the process of cognition is lost. These transformations involve "semantic twists" or "pathological semantics" whereby the descriptive metaphors shift the responsibility for action from man to machine (von Foerster, 1970a, p. 237). The consequence of trivializing cognition is that we impede our understanding of it. As man is determined by his constantly changing internal states, he cannot be understood as a trivial machine. Thus when we reduce our explanations to triviality in our desire to predict and reduce uncertainty, we cannot succeed: "If one wants to use the word 'reality', the

nontrivial machine models the reality with which we are working. The trivial machine is just a hope, a predicted wish for the way we would like things to be" (von Foerster, in Segal, 1986, p. 108). Thus, suggests von Foerster (1970b), we can undertake "a search for mechanisms within living organisms that enable them to turn their environment into a trivial machine, rather than a search for mechanisms in the environment that turn the organisms into trivial machines" (p. 184).

Language

Segal(1986) includes a chapter in his book entitled "The Difficulties of Language" in which he presents a collection of von Foerster's major themes relating to language. While a detailed treatment of these themes is not essential vis-a-vis the ensuing discussion, what is important is to establish that language affects the way we experience our reality. Segal writes that

> Language, operating below our level of everyday consciousness, structures our thinking by punctuating circular streams of interaction into one-way causalities. It nominalizes processes and unwittingly seduces us into habitual causal schemes for explaining the world. When paradoxes arise, shaking us loose from our traditional habits of logic and reason, we want to eliminate them. We long for certainty, holding on to the belief that the world can be understood in our true/false logic. (p. 58)

Representation. "Re-presentation" refers to the notion that we speak as though what we perceive exists independent of the observer. For example, we describe the sound of a violin rather than "periodic variations in air pressure which travels in space." The quality of sound that is experienced is in fact due to operations within the nervous system of the individual who hears it rather than something which is emitted by the playing of the violin. Thus language hides our participation in perception by defining sound as an "objective property of the world" which is independent of the observer.

Nominalization. "Nominalization" occurs when verbs are turned into nouns thereby converting processes or actions into things, "allowing us to create things out of thin air." For example, "a horse gallops" becomes "a horse has a good gallop", as though "the horse possesses a gallop the way he possesses horse shoes." Segal points out that nominalization occurs in many domains and entices us to treat them as commodities. The nominalization of information and "knowledge" transforms them from processes into commodities which are treated as though they can be passed on, thereby confusing the creation "of new processes with the dispensing of goods called 'knowledge'".

Logical Syllogism. "Logical Syllogism" is a system of reasoning used to make inferences that implies that correct reasoning can uncover truths which exist a priori

in the mind. They contain three parts: (1) a major premise, (2) a minor premise, (3) a conclusion, in which the conclusion follows from the other two. An example of a deductive syllogism is: all men are mortal; Socrates is a man; therefore Socrates is mortal. However, as von Foerster indicates, the "conclusion is a logical necessity of the syllogism, not a necessary fact about Socrates." Further, "the syllogism misleads us into attributing the observer's properties to the observed system. We unconsciously invent these properties with logic and assume we discover them in the systems we observe" (Segal, 1986, p. 41). Inductive syllogisms involve inferring the general from the specific and "is the basis of natural science". However because their logical structure is fallible, "errors will occur."

Paradox and Self-Reference. A paradox which "contains a proposition which is true when it is false and false when it is true", results from self-referential statements (e.g. I am from Crete and all Cretans are liars). The truth or falsity of a paradox cannot be determined and thus the rule that all propositions are either true or false is undermined. Bertrand Russell saw the solution to the problem of self-reference in his Theory of Logical Types in which he separated "class" from "class membership". His solution was to forbid the consideration of the "class" or "set" as one of its own elements. Von Foerster maintains that this solution is no solution as it

entails treating the observing and observed systems as always different and does not permit us to examine our own experience. Further, logical mistyping (mixing levels) is essential to "humor, poetry, learning and creativity."

Causality. There is a heavy reliance on the use of "efficient causality" (cause precedes effect) to explain most observed phenomena, although, as von Foerster points out, we are severely limited by this form of explanation. A causal explanation is comprised of "a cause, an effect and a rule of transformation" which "acts on the cause and produces the effect." For example, if a boss issues a directive to a worker who then carries it out effectively, the rule of transformation might be the boss's goal setting or task structuring, implying a one-way causality. "Final causality" refers to "causes which beckon from ahead" rather than "push from behind", i.e., the effect precedes the cause. For example, "I am performing this task"(effect) "in order to achieve a goal"(cause). A combination of efficient and final cause are present in the concept of feedback, or circular causality. According to Segal,

> If we have four events -- a, b, c, d -- the traditional causal arguments took two forms: efficient causality in which a causes b which causes c which causes d; or final causality, in which d, working backwards, causes a. Cybernetics showed that when d feeds back to a, both causalities are

> operating, which cyberneticians call circular causality: a causes b causes c causes d cause a. (p.54)

Cybernetics accounts for the relationship between stabilities in one part of the system and changes in another part: "the tightrope walker must constantly shift his weight(first-order change) to stay on the rope(second-order stability)".

Constructing Explanations. "Constructing explanations" refers to the way that "language blurs the distinctions between descriptions and explanations". Segal presents von Foerster's analysis of Bateson's metalogue on instinct which is essentially an illustrative parable. Instinct is revealed as an explanatory principle rather than a description of a substantive process. Von Foerster identifies the semantic, dialogical and political significance of this shift:

> instead of addressing ... the semantic significance of [the] question, he immediately shifts the focus ... to its dialogical significance. What is the political significance of language? What happens when someone uses the word instinct in a dialogue? What consequences does language have for our thinking and behavior? (p. 57)

Von Foerster points out that, while a law is a legal issue in a social context, a law of nature is an explanatory principle.

In "Molecular Ethology" (1970b), von Foerster's "Immodest proposal for semantic clarification" he maintains that the coherence of various conceptual domains is provided by the concept of "recursive functionals" which provide the links for interpreting the structures and functions of living organisms as autonomous and self-referring: "When these links are ignored, the concept of 'organism' is void, and its unrelated pieces becomes trivialities or remain mysteries" (p. 185). Thus to the extent that language structures circular processes into lineal unidirectional causalities, trivial machine metaphors are generated. In von Foerster's statement that "learning is not a mapping of some external environment, but what the system does in order to transform its environment" (Varela, 1984, p. xv), the juxtaposition of semantic confusion and clarification can be seen.

Recursion

Once again this discussion follows Segal's presentation of von Foerster's concepts. Recursion means "to run through one's own path again" (von Foerster in Segal, 1986, p. 164). As stated above the concept of recursion is central to the notion of self-reference and organizational closure, as it is an expression of how systems produce themselves. This is seen in the closure of the nervous system (discussed earlier), in the regulation of its regulation, and in the closure between cognizer and cognition. Von Foerster introduces

"recursive function theory" as a formalism to illustrate systemic closure and the production of stable behaviors in self-organizing systems. The reader is referred to a primary source for a full explanation of recursive function theory. In simplified terms, it expresses the relationship between operators (O) and variables (X) in the production of stability, specifically demonstrating how stability arises from an infinite sequence of operations. This infinite sequence is expressed by the equation: $X=Op(Op(...(X)...))$, for which a solution in the form of a "self-value" is produced. The value is analagous to the value produced by the sentence "This sentence has _____ letters." Thus "the solution to these problems shows that certain stable values emerge from infinite recursive computations". These self-values are called eigen-values which are produced by "a continuous sequence of recursive operations (operations on operations)" (Segal, 1986, p. 140).

While this point is bound to seem abstruse to the reader, it has implications which are important to an understanding of behavior and cognition. Von Foerster presents an example of an infant playing with a rattle where, through a series of manipulations, the infant becomes familiar with it. When the infant develops a stability of behavior with the rattle in the sense that he can control it and make full use of it, he experiences it as a constant. He has developed sensorimotor competence;

"there is no toy; there is only a stable sensorimotor behavior [because] the child only has access to what is represented on the retina and sensory tactile sensations arising from the operation on the rattle" (Segal, 1986, p. 139). The stable sensorimotor behavior represents an eigen-value. Eigen-values are recursive functions which produce themselves through a mechanism described by the operation of closed systems, that is, "it is the operation that always produces its own entities" (p. 141). Eigen-values are what we experience as the "objects of perception". An observer who sees a child playing with a ball (an object)

> nominalizes his own sensorimotor experience, the correlation between the image on his retina and the movement of his eyes. The child only senses the constraints of his actions imposedby what our object language denotes as a ball. These constraints control his behavior and this control must have a particular form.
>
> Push against a chair, and it will "object" to your movement. Interacting with it organizes your sensorimotor behavior. Thus, it is experienced, with the help of language, as object. The chair constrains your behavior, allowing a convergence of sensorimotor behavior to stabilize with respect to that chair (object). This is how the constructivist explains objects. (p. 142)

Thus objects are tokens for eigen behaviors. The objects that we refer to in language arise in our recursive sensorimotor behavior when we interact with them.

Language is also an eigen behavior, but one which von Foerster asserts has come about "through recursive interactions of all of us" (Segal, 1986, p. 165). The process by which this occurred is not available to us because it occurred in the history of its evolution "which is now embedded in [its] form." While language can be viewed either from an ontological perspective (how it is) or ontogenetically (how it arose), von Foerster indicates that it cannot be understood in terms of the former: "when you don't see how things become, you may not see how things are".

Solipsism, Identity, and Ethics

When an individual experiences an object, it appears to reside in his own subjective experience. When an individual distinguishes another individual, a social context is created in which each individual's "experience of his own sensorimotor coordination can now be referred to by a token of this experience, the 'object', which, at the same time, may be taken as a token for the externality of communal space" (von Foerster, 1976, p. 280). Under these circumstances where the eigen behaviors of each individual recursively generate those for the other, a meta-eigen value obtains, referring to a stability of the communal space, in which "cognition computes cognition

through those of the other" as described by "one snake [eating] the tail of the other as if it were its own." This, posits von Foerster, is the origin of ethics.

This notion is expanded in von Foerster's differentiation of constructivism and solipsism; they differ when we talk about more than a single organism. A single observer claiming that his is the only reality encounters difficulty when he must admit that there are other observers in his universe who also may insist that their reality is the only one. In order to defeat the solipsistic claim, von Foerster invokes the "principle of relativity, which rejects a hypothesis when it does not hold for two instances together, although it holds for each instance separately" (von Foerster, 1973, p. 59). Thus more than one autonomous organism cannot be the only reality. Von Foerster further indicates that we are not obliged to choose to adopt this principle, but

> If I reject it, I am the center of the universe, my reality is my dreams and my nightmares, my language is monologue, and logic monologic. If I adopt it, neither I nor the other can be the center of the universe. As in the heliocentric system, there must be a third that is the central reference. It is the relation between Thou and I, and this relation is <u>identity</u>:
>
> reality=community

What are the consequences of all this in ethics and aesthetics?

The ethical imperative: Act always so as to increase the number of choices.

The aesthetical imperative: If you desire to see, learn how to act. (von Foerster, 1973, p. 60)

Segal (1986) elaborates the significance of the ethical imperative, reporting von Foerster's belief that ethics arise out of choice: choosing the principle of relativity and identity between oneself and another "can only arise from acknowledging another person".

Maturana and Varela

Maturana and Varela's initial focus on the issue of self-organization began with an examination of biological systems. Studying the frog's retina, they discovered that the frog does not perceive objects in the environment, but rather , what is perceived is determined by the structure of the frog's neurophysiology (Simon, 1985). This finding supported Maturana's early conceptualization of living systems "in terms of the processes that realized them, and not in terms of the relationship with an environment" (Maturana and Varela, 1988, p. 10), that is, living systems have a closed circular organization. The study of the interactional or social domain and the role of the processes of language in producing it were a natural outgrowth of these concepts. Maturana and Varela coined the term "Autopoiesis" from the Greek "Auto" meaning

"self" and "poiesis" meaning "production" to refer to processes of self-production (Autopoiesis) which define the closed circular organization of living systems (Maturana and Varela, 1980). Zeleny (1980) indicates that Autopoiesis

> belongs to the newly emerging category of paradigms addressing the issues of self-organization and spontaneous phenomena within physical, biological, and social systems ... Autopoiesis is the most recent of these concepts, and perhaps the most radical and controversial, but it is also the most general and has the potential of encompassing all the others. (p. xv)

The theory of Autopoiesis describes the dynamics of living systems and has become fundamental to the explanation of their properties. As such, it is a relatively comprehensive expression of an ontological foundation of living systems with implications at different levels of analysis, including the relations between entities distinguished at different levels of analysis.

Overview

Autopoiesis is a theory of the organization of living systems in relation to their unitary character. An autopoietic system is organizationally invariant, and closed in the sense that it sustains its own organization. To exist in the space of its components, however, it is materially and energetically open, although closed

dynamically. The components of an autopoietic system can vary, and are specified by its autopoietic organization. They cannot be identified by an observer independent of the system which they integrate. The unity of an autopoietic system is the result of the interactions of its components but not a result of interactions or relations that imply the whole that they produce. Nothing occurs in the operation of the system with reference to its unity. Consequently, regulation and control exist only in the metadomain of an observer's descriptions of the system as a whole and do not characterize the interaction of its components.

Following the discussion of Maturana (1980), several basic notions can be formulated. Unity is defined through the cognitive operation of distinction. By recursively applying the operation of distinction to a unity, we distinguish its components and redefine it as a composite unity. A system treated as a composite unity exists in the space defined by its components, and a system treated as a simple unity is characterized through the distinctions that define it as a simple unity.

The organization of the composite unity is defined by the relations between its components. The actual components together with the actual relations that realize a system as a particular member of the class of composite unities to which it belongs by its organization constitutes its structure. The organization of a system

is a subset of its structure and therefore an organization can be realized through variations of structure. If the identity of the system is to remain invariant, so must its organization. However, the identity of a system can remain invariant while its structure changes within the limits determined by the organization. If the structure changes so that the organization is destroyed, the system becomes something else. A simple unity only has properties that are defined through the observation of distinction, which separate it from a background, whereas a composite unity has both structure and organization.

While a simple unity exists in a space which it defines, a composite unity exists in a space defined by its components because it is distinguished as a unity through the properties of its components. However, a composite unity can be treated as a simple unity. A simple unity is specified in a phenomenic domain that is different from that which specifies a composite unity. Consequently, the emergence of a phenomenic domain as the result of the operational distinction of a composite unity as a single unity makes phenomenic reductionism impossible. Importantly, regulation, control, or function are not relations of contiguity, but are "referential relations specified by the observers putting themselves in a metadomain of descriptions, by using their view of the whole as the reference for their description of the

participation of the components that they describe in the constitution of the composite unity" (p. 26).

The structure of a composite unity determines which structural configuration of the medium in which it operates may perturb it, although the actual perturbations that take place are determined through interaction with the medium. The structural coupling between a composite unity and its medium appears as a behavioral complementarity in which the "conduct of the system is congruent with the changes of state of the medium in a manner that permits it to continue in its autopoiesis" (p. 27). An Autopoietic system is defined as a unity through relations of form rather than relations of energy transformation, i.e., a structure determined system.

The operation of distinction is the basic cognitive operation that an observer performs, and the observer can endlessly create new simple and composite unities. An observer characterizes a unity by stating the conditions in which it exists as a distinguishable entity, but perceives it only to the extent that a metadomain is defined in which it can be treated as the characterized entity. Consequently, complementarities of system-environment, autonomy-control, etc., are in our cognition of the system, but are not constitutive features of the system being observed. Descriptions exist in the metadomain.

Maturana and Varela's basic ontology thus asserts that living systems can be understood in relation to their unitary character and that their identity is self-produced and organizationally closed. The fundamental ontological claim of structure determinism ultimately addresses "the epistemological status of objectivity, the problem of the observer and the relation between Geisteswissenschaften and Naturwissenschaften" (Dell, p. 16). Several themes based on these broad issues can be delineated, recognizing that they are conceptually interdependent and difficult to discuss in isolation from each other. As several writers have contributed to the development of these themes, allusion to their explanations and distinctions can embellish the discussion.

Radical Constructivism

Radical constructivism is the first major theme and holds that all knowing, understanding, and communicating are constructions of an observer rather than a reflection of an external reality. Two primary components of radical constructivism are that nothing exists without an observer and that objective knowledge is ontologically impossible. Both are derived from notions that the things we perceive are the products of our own nervous systems and thus that the environment contains no information. The operational closure of cognizing systems manifests a recursive relationship between cognizer and cognition in which the cognition is a function of the cognizer which is itself a

function of the cognition; they "recessively depend on each other for their maintenance and realization; they form a recursive closure" (Zeleny, 1980, p. 5). The same pattern operates at the level of the observer of the relationship between cognition and cognizer, whose own cognition follows similar recursions (Varela, 1984). The distinction of patterns which are labelled radical constructivism is itself a cognitive operation of observers who are constructing patterns. Thus, radical constructivism itself does not reflect an absolute reality (Von Glasersfeld, 1984). Consequently, an observer does not perceive phenomena in the environment (i.e., does not receive input), but rather, carries out the fundamental cognitive operation of distinction, by which an entity is distinguished from a background, as determined by the structure of the observer and not the medium observed. Thus, the responsibility for a distinction lies with the observer rather than reflecting characteristics of the medium. Structure determinism literally means that what an observer distinguishes is a function of his structure rather than a representation of an objective reality which exists apart from the observer. An observer brings forth his reality, in spite of his experience of observing an objective reality that seems to exist apart from his act of bringing it forth; the cognitive act of bringing forth a reality is blind to itself. Thus we do not see that we do not see.

Radical constructivism is not the same as solipsism, where a world does not exist except in the mind of the observer. There are two traps to be avoided. The first is "the trap of assuming that the nervous system operates with representations of the world [that] blinds us to the possibility of realizing how the nervous system functions from moment to moment as a definite system with operational closure"; the second is to deny "the surrounding environment on the assumption that the nervous system functions completely in a vacuum, where everything is valid and everything is possible" (Maturana and Varela, 1988, p. 133). Maturana and Varela suggest that avoiding these traps requires us to employ a broader context by recalling that everything said is said by an observer:

> As observers we can see a unity in different domains, depending on the distinctions we make. Thus, on the one hand, we can consider a system in that domain where its components operate, in the domain of its internal states and its structural changes. Thus considered, for the internal dynamics of the system, the environment does not exist; it is irrelevant. On the other hand, we can consider a unity that also interacts with its environment and describes its history of interactions with it. From this perspective in which the observer can establish relations between certain features of the

> environment and the behavior of the unity, the internal dynamics of the unity are irrelevant.
>
> Neither of these two possible descriptions is a problem per se: both are necessary to complete our understanding of a unity. It is the observer who correlates them from his outside perspective. It is he who recognizes that the structure of the system determines its interactions by specifying which configurations of the environment can trigger structural changes in it. It is he who recognizes that the environment does not specify or direct the structural changes of a system. (p. 35)

Maturana and Varela thus indicate that we must maintain a logical accounting between the two realms. Even though as observers we see them simultaneously we must resist the temptation of framing the correspondences between the two as part of the operation of the unity (Maturana and Varela, 1988). "In this way we do not need to fall back on representations or deny that the system operates in an environment that is familiar owing to its history of structural coupling" (p. 136).

Maturana and Varela clearly eschew the conception of the brain as an information processing device with inputs and outputs. The operational closure which makes this impossible leads us to reformulate the way we view knowledge. An observer imputes knowledge whenever he observes "an effective (or adequate) behavior in a given

context, i.e., in a realm or domain which we define by a question (explicit or implicit)." (Maturana and Varela, 1988, p. 174). This means that knowledge arises in the interaction between observers, i.e. in a relational context. Von Glasersfeld (1984) indicates that radical constructivism means that all we can ever know about the world is what it is not. He juxtaposes the terms "match" and "fit" in relation to "metaphysical realism" and "radical constructivism" respectively. The metaphysical realist tries to match his knowledge to reality to discover relations which exist in the world, whereas for the constructivist there is no world prior to experience. Knowledge is viable when it stands up to experience, but even then represents only one possible explanation which fits the experienced world. Nothing is implied about the nature of reality and the many possible alternate explanations of a world beyond our experience. If knowledge does not serve our purpose of explaining phenomena that we experience, it does not fit, and thus is rejected or repudiated. Thus knowledge is seen, not as a "search for an iconic representation of ontological reality, but instead as a search for fitting ways of behaving and thinking" (p. 39).

Instructive Interaction

The ontological impossibility of instructive interaction is a major theme deriving from the notion that the structure of the system, rather than events or

perturbations in the environment, are the determinants of behavior of the system. Events in the medium, are merely the occasion for the system to continue in the production of its identity, but do not instruct how the system will respond. Organizational closure means a unity does not receive information from outside, and therefore does not function like an open system with input and output. Thus, interactions with a medium cannot be specified from outside the system as they are structure determined. Beer (1980) indicates "that the labelling of connections between the system and the environment as either inputs or outputs is a process of arbitrary distinction" (p. 67). This means that an autopoietic system cannot be controlled by something external to it. Structural changes occur as a result of either the system's own dynamics or are triggered by their interactions (Maturana and Varela, 1988), although the interactions do not specify the behavior of the system. A perturbation can select a response, but only if it is within the range of response capability of the structure of the unity. Instructive interaction is imputed by an observer who views a unity in interaction with an environment and mistakenly attributes the changes of state in the unity as being caused by or under the control of configurations of the environment.

Purpose/Goal Directedness

The myth of instructive interaction is manifested in cybernetic accounts of regulation and control, or other

less systematic treatments of control and causality applied to living systems. A similar ontological error is expressed in the misapprehension of purpose and goal-directed behavior. As Maturana and Varela point out, "all behavior is an outside view of the dance of internal relations of the organism" (p.166). Thus as observers we judge whether or not a behavior is appropriate in a particular context and in so doing overtly or tacitly ascribe a purpose or a goal which defines the expectations of the observer rather than the internal relations of the organism.

A structure determined system has only one purpose, which is to maintain its identity. Any additional purpose attributed to a system is an interpretation by an observer and as such exists in a metadomain. An autopoietic system distinguished by an observer as a unity "defines a space through its operation as a whole" whereas "nothing takes place in the operation of the autopoietic network with reference to the unity of the network" (Maturana, 1980, p. 23). Consequently, an observer viewing a system as a composite unity can invoke distinctions of regulation and control that exist in the metadomain of description, but do not characterize the interactions of the system's components.

Purpose or functions imputed to an autopoietic system may serve the agenda of the observer, but "have no explanatory value in the phenomenological domain which

they pretend to illuminate, because they do not refer to processes indeed operating in the generation of any of its phenomena" (Maturana & Varela, 1980, p. 86). An autopoietic component of a composite system can be viewed by an observer in terms of its role in fulfilling the purpose of the composite system. In this case, it is seen as an allopoietic process in that its purpose is seen to be to produce something other than itself (Zeleny, 1980). However, such a description exists purely in a metadomain. A major consequence of this is that notions of hierarchy, implying domination and control from the top down, exist only in the metadomain of observer description. Capra (1982) indicates that the organization of complexity rather than the transfer of control is the important aspect of stratified order, and points out that "any level under consideration is really the level of the observer's attention" (p. 292). Similarly, as Beer (1980) indicated, a "system is not something presented to the observer, it is something recognized by him" (p. 67). Furthermore, a potential result of an observer distinguishing hierarchically organized autopoietic systems is that the unity which is viewed as an allopoietic component of a larger system can cope with "treatment which attempts to deny its own autopoiesis" (p. 70). Thus an observer is epistemologically in error when he views an embedded system in terms of the goals or purposes of a larger system and assumes that his view represents the operation

of the embedded system. Consequently, an observer attributes goals or purposes in the context of his evaluation of behavior in a particular environment. This could entail reifying a hierarchical description in which the internal relations of a unity are erroneously subjugated.

Structural Coupling

Structural coupling refers to the fundamental process by which structure determined entities become organized into complex systems; it describes the relationship between a structure determined entity and its medium and is the basic element of "all human and animal interaction systems (Dell, 1985, p. 13). An autopoietic system must couple with its medium in order to exist. Through the course of its ontogeny a unity undergoes ongoing structural change in interaction with its medium. Structural change, in this case, occurs continuously with each interaction with the environment, which is seen in accordance with the structure of the unity. "We human beings are modified by every experience, even though at times the changes are not wholly visible." (Maturana and Varela, 1988, p. 168). Coupling occurs due to structural plasticity. As a result of interacting with other systems, the structure of a system will change and thereby affect the behavior of the future interaction system. Therefore, the nature of the coupling between a system and the perturbations of its medium can change over time.

However, when two or more systems couple and form a new unity, their individual autopoiesis will give rise to mutual perturbations in each other's milieu that cannot overstep the bounds of variation within which each system's autopoiesis can continue (Maturana & Varela, 1980). Otherwise, they cannot couple. Conservation of autopoiesis has primacy with respect to structural coupling. Structurally coupled systems behave according to the interaction of each structure-determined system. Thus, notions of regulation and homeostasis do not characterize the interaction (Dell, 1985).

An autopoietic system can exist in several domains of structural coupling, and consequently cannot be comprehensively described in terms of one dimension. Any such descriptions exist in a metadomain. However, through their interactions, structurally coupled systems develop modes of conduct which appear as a consensual domain, even though the behaviors involved are arbitrary and contextual (Maturana, 1980). That is, they are defined only in the context of the interactional domain, and apart from their operation as triggering perturbations in the interactions they can have any form. An observer making a description is operating in a consensual domain which is a necessary aspect of structural coupling. Structural coupling maintains compatability between the operation of the organism and its environment. To an observer this appears as learning, although it is really only ongoing structural

drift where the adaptation of the unity to its medium of interaction is conserved.

The history of structural change in a unity without loss of its organization comprises its ontogeny, which continues as long as the unity conserves adaptation. When recurrent interactions occur between two or more unities, they experience co-ontogeny. It is important to note that to each of two autopoietic unities, the perturbation of the other is "indistinguishable from those which we, as observers, classify as coming from a 'nonbiotic' environment" (Maturana and Varela, 1988, p.75).

Social Systems

Ontogenic co-drift between unities in a recurrent manner results in "Third-order structural couplings" (first- order structural coupling occurs between a unity and its environment; second-order structural coupling occurs between organisms), which characterize social phenomena. A social system involves the co-ontogeny of its components and their "reciprocal structural coupling" so that an observer "can describe a behavior of reciprocal coordination between them." "Communication" refers to the observation of behavioral coordination which results from social coupling. In this view communication does not contain information; to speak of communication is to speak of structural coupling in a social domain. Structural coupling in a human social system occurs through language. The comparison between a human being in a social system

and a component in an organism reveals the important role of linguistic behavior in social coupling. Maturana and Varela (1988) state that human systems exist

> as unities for their components in the realm of language. Therefore, the identity of human social systems depends on the conservation of adaptation of human beings not only as organisms (in a general sense) but also as components of their linguistic domains. Now, the evolutionary history of human beings is associated with their linguistic behavior. It is a history wherein that ontogenic behavioral plasticity is chosen which makes linguistic domains possible and wherein the conservation of adaptation of human beings as organisms requires their operation in those domains and the conservation of that plasticity. Just as the existence of an organism requires the operational stability of its components, the existence of a human social system requires the operational (behavioral) plasticity of those components. Just as organisms require nonlinguistic structural coupling between their components, human social systems require components structurally coupled in linguistic domains, where they (the components) can operate with language and be observers. (p. 198)

Thus human beings generate a linguistic domain, which is the currency of structural coupling and which comprises

the social system which recursively depends on it for its existence. The ontology of organisms and social systems thus specifies an important divergence: the components of organisms exist for the organism, whereas a social system exists for its components. The components of organisms are therefore necessarily restricted in their operation whereas the components of social systems are multifarious. Maturana and Varela (1988) indicate that communities become impaired systems and lose their vigor when they restrict all the behavioral dimensions of their members, treating them as depersonalized components of an organism. Maturana and Varela no doubt share Bateson's aversion to the misuse of power and control.

Language

Social systems are ordained in linguistic domains which ultimately arise out of the process of structural coupling between unities in a medium. In the previous discussion it was stated that the social domain arises through recurrent interaction between unities in "reciprocal structural coupling." This social domain is also a linguistic domain, comprised of linguistic behaviors, which appear as coordinations of actions to an observer. Linguistic behavior is not identical with language, but refers to pre-language communicative behaviors which appear as coordinations of action, and which are the basis for language. In observing coordinations of action an observer can make a semantic

description in which the interactions are treated as though they are determined by the meaning the observer ascribes to them rather than the internal processes of structural coupling. Maturana and Varela (1988) point out that semantic descriptions are easily made in the context of a history of interactions in which an observer can claim "that the meaning of the different communicative behaviors arises in the ontogeny of the participant organisms, contingent on their particular history of coexistence" (p. 207). Thus semantic descriptions arise from recurrent interactions, but have no explanatory value with respect to the operation of autopoietic systems. Maturana (1978) indicates that

> Representation, meaning and description are notions that apply only and exclusively to the operation of living systems in a consensual domain, and are defined by an observer to refer to second-order consensual behavior. For this reason, these notions have no explanatory value for the characterization of the actual operation of living systems as autopoietic systems, even though they arise through structural coupling. (p. 50)

From the domain of linguistic coordination of actions arises language, a phenomenal domain. "In the flow of recurrent social interactions, language appears when the operations in a linguistic domain result in coordinations of actions about actions that pertain to the linguistic

domain itself" (Maturana and Varela, 1988, p. 210). Thus language is the coordination of conduct about coordination of conduct (Dell, 1985), or as Maturana termed it in the previous quote, second-order consensual behavior. Thus to structurally couple through language is to operate in a consensual domain in which unities coordinate their actions. Language enables an observer to make distinctions and bring forth objects and meanings which are constructions in language in a consensual domain; "we are observers and exist in a semantic domain created by our operating in language" (Maturana and Varela, 1988, p. 211). Interacting in a consensual domain, an observer, as an organizationally closed system, makes distinctions in language which are his own unique constructions, saying nothing about either an objective reality or other observers. Thus we are a "multiverse, rather than a universe" (Dell, 1985, p. 16). The realities that we create are our own. They arise from our conversation and "become part of our domain of existence and constitute part of the environment in which we conserve identity and adaptation" (Maturana and Varela, 1988, p. 234). It is only in language that we are observers, and consequently, distinctions are made through our operation in language. As Maturana and Varela (1988) so eloquently state:

> Language was never invented by anyone only to take in an outside world. Therefore, it cannot be used as a tool to reveal that world. Rather, it is by

> languaging that the act of knowing in the behavioral coordination which is language, brings forth a world. We work out our lives in a mutual linguistic coupling, not because language permits us to reveal ourselves but because we are constituted in language in a continuous becoming that we bring forth with others. We find ourselves in this co-ontogenic coupling, not as a preexisting reference nor in reference to an origin, but as an ongoing transformation in the becoming of the linguistic world that we build with other human beings. (p. 235)

Correspondences between behavior and language arise in the recursive relationship between descriptions and interactions. Thus Maturana (1978) indicates that a "constitutive homomorphism" exists "between descriptions, and behavior in general, and the operation of the systems that describe. Therefore, we literally create the world in which we live by living it" (p. 61). In a consensual domain the actions that are coordinated are linguistic ones which arise in the recursive processes of closure in a context of structural coupling along an ontogenic drift. If there is no distinction there is no action.

Consensual Domains

The term "consensual domain" does not designate a social system in which the multiverse becomes homogenized into a universe. A consensual domain is a social system that is brought forth in the structural coupling in

language of two or more participants, but indeed as members of social systems we all continue to construct our own realities. Different social realities are therefore brought forth by every observer, even though they include at least one other observer. As has been stated with regard to families, there are as many families as there are observer descriptions. While certain elements of each description may correspond, each family member has a unique and legitimate "family reality" (Efran & Lukens, 1985). The term "consensus" does not necessarily designate an interaction system in which semantic agreement necessarily emerges. In fact it refers to "the states of the participants as they trigger each other in interlocked sequences of changes of state" (Maturana, 1978, p. 50), that is, it refers more to the dynamic structural coupling in language rather than what is denoted in the act of structural coupling in language. Consequently, two participants are in a consensual domain (in the sense of arising through the interaction of closed systems) even if they appear to an observer to be engaged in a "schismogenic" interaction, such as an argument. Thus two unities will remain in a consensual domain triggering mutual perturbation in a recursive manner that select ongoing changes of state until either "some behavior is triggered that does not belong to the consensual domain, or because some independent

intercurrent interaction occurs that leads them out of the consensual domain" (Maturana, 1978, p. 53).

The Politics of Science

A consequence of operations of constructivism and consensual domains is that "science" must abandon claims of uncovering "truths" about an objective world out there. All human endeavors arise in recursive networks of closed interactions in language and thus are subject to the semantic imperative of these consensual domains. Thus conversations about science entail semantic elements of description, specification, and meaning, which are observer dependent. Consequently, these semantic constructions cannot be considered independently from the "mind set" of the observer. Though a group of observers may share a common set of precepts in a consensual domain and there may be overwhelming agreement that these precepts are representations of an external world, indeed they are productions in a metadomain of description. Thus, as Efran, Lukens, and Lukens (1988) indicate, "science turns out to be a political 'club' of sorts, with its own specialized canons of operation and stringent rules of membership" (p. 29). Of course this view of science is not novel and is wholly consistent with social constructivist notions developed through a different community of observers. For example, the hermeneutic approach to the human sciences recognizes that conduct is rooted in semantics rather than "logical or causal

organization" and that "social action is understood by people in a manner that is influenced by their own interests and projects and is just not available in the same way to an objective, detached, and disinterested observer" (Packer, 1985, p. 1086). While elements of a tacit, if not de facto constructivist approach are noticeably represented in formal theory with respect to the human domain, most observers would likely find highly counter-intuitive the assertion that formal theories relating to the physical domain are also socially constructed. But Jones (1982), who states that space, time, matter, and number are the "cardinal metaphors" of physics, indicates that indeed this is the case. The increasing frequency with which challenges are levelled toward the traditional "objective, ahistoric and individualistic" conception of knowledge courts the formulation of a metatheory which would place knowledge "in the hands of people in relationships" and make it "the responsibility of persons in active, communal interchange" (Gergen, 1985). Certainly, the theory of autopoiesis accomplishes this, both in reference to formal knowledge and the informal knowledge brought forth in each distinction. The "correctness" of both are determined by consensus, which is bound up in the interests of the observers, and hence is of a necessarily political character.

III. ORGANIZATIONS AS LIVING SYSTEMS

Summary of Essential Elements of Living Systems Theories

The theories of Bateson, von Foerster, and Maturana and Varela can be seen as epistemologically consistent, but not equivalent accounts of the operation of living systems. While each offers a rich set of distinctions which explicate certain phenomena in their own individual fashion, collectively they present a comprehensive topography which broadly describes living systems in terms of the processes that realize them. A detailed interweaving of the ideas of Bateson, von Foerster, and Maturana and Varela would be a complex undertaking which is not the intent of this discussion. What is important here is to introduce a language of living systems in terms of which organizations can be discussed - to create an analytic lens with which to apprehend certain kinds of organizational phenomena.

As a comprehensive explanation of the broad class of operations constituting the closed organization of living systems, autopoiesis in many ways provides coherence to many of the related concepts of Bateson and von Foerster which deal with the characterizations of living systems, particularly with respect to social systems. Autopoiesis represents an encompassing cosmology. Yet this does not detract from the value of Bateson's and von Foerster's work in facilitating the exploration of the significance of living systems notions to the study of work

organizations. Bateson was, to some extent, presented here as a sort of aperitif to von Foerster and Maturana and Varela. Although Bateson's distinctions will be alluded to in the ensuing discussion, the work of von Foerster and Maturana and Varela are more focal to the major themes. The concepts of all of these writers can serve as epexegesis to each other and their explanatory value drawn upon at appropriate junctures to enlighten the characterization of work organizations as organizationally closed systems.

Even though these theorists offer different accounts of the operation of living systems, to some degree their discourse contains shared dominant themes which can be briefly recapitulated. They share an interest in the nature of language and explanation, including their epistemological and ontogenetic significance. The production of autonomous stability in systems through recursive operations is reflected in the notions "mind", "eigenstate", and "autopoiesis", all of which establish the circularity of organization that is the basis of living systems. This circularity implies that living systems are closed and thus do not receive information from the environment. We cannot specify the behavior of a system in reference to its interactions with the environment because it does not operate in terms of input and output. Thus the structure of the system determines how it will behave, not the structure of the environment;

living systems operate as nontrivial machines whose behavior depends on internal states. Composite unities behave according to the dictates of their structures, which means that they are determined by their components and by the relations among components. The only purpose a composite unity has is to conserve its organization (invariant relations between components) and maintain adaptation (the coupling of the system with the medium).

Maturana and Varela, Bateson, and von Foerster share an interest in the nature of language and explanation including their epistemological and ontogenetic significance. The terms "cybernetic epistemology", "second order cybernetics", and "constructivism" all refer to the operation of observers drawing distinctions and bringing forth realities. Distinctions are determined by the structure of the observer operating in language and not the medium observed. We can never reveal objective truths; all that our distinctions reveal is our operation in language. As observers we bring forth and exist in a social domain wich arises in our recurrent interactions in language. Thus we coordinate our conduct and engage in discourse about coordination of conduct. A social consensus determines the truth or value of various distinctions brought forth by observers, even though in absolute terms all observations are equally valid because objective knowledge is impossible. Knowledge is something that is consensually validated and thus exists only in the

interactions of observers. Further, it is as observers drawing distinctions that we impute meaning to events by punctuating them in terms of cause and effect according to our own ontogenesis and histories of structural coupling.

When we draw distinctions in language and introduce them to the medium in which we exist, they become part of our existence and part of the medium in which we conserve our organization (identity) and adaptation. Thus the descriptions and distinctions that we create and introduce into our medium recursively generate the conditions which they describe. These conditions then, in turn must be contended with. That is, the distinctions are recursive functionals which generate eigenstates.

Bateson, von Foerster, Maturana and Varela all spoke of pathology, dysfunction, or impairment and the conditions which create it; this invariably occurs in the context of observers making distinctions in a social milieu. Maturana and Varela describe how observers come to believe in instructive interaction and fail to logically account between the operation of the organism and the domain in which it interacts. They identify the impairment in human social systems that occurs when they are treated like organisms whereby the behavior of members is restrained by "enforced mechanisms of stabilization". Bateson was concerned with what he termed "epistemological errors", believing that attempts to control and belief in lineal causality in non-mechanical domains led to

pathology. Dell (1985) points out that Bateson's belief in circular causality spawned his distaste for lineal causality. Circuits of causality constitute the basic pattern underlying Bateson's notion of schismogenesis and his fourth criterion for mind, that "mental process requires circular (or more complex) chains of determination" (Bateson, 1979). Bateson indicated that "lineal thinking will always generate either the teleological fallacy (that end determines process) or the myth of some supernatural controlling agency" (p. 66). The parallel between the notions of instructive interaction vs. structure determinism and lineal vs. circular causality is drawn by Dell (1985). The ubiquitous psychological experience of causation is an "epistemic consequence of our ontological status" as observers existing in the physical world, who "punctuate what we see as involving causality and, in turn, characterize the world in which we live as a causal one" (Dell, 1985, p. 8).

Von Foerster's explication of "trivialization" outlines how we try to trivialize our environment and asserts the danger of man applying trivialization to himself. Trivialization was also seen to be associated with pathological semantics which turn circular processes into lineal ones and create a sense of predictability and certainty.

Organizations as Social Systems

The application of living systems theory to the explanation of work organizations is initiated in the following discussion beginning with a preliminary framing of work organizations in this context. Following this several issues regarding the significance of living systems notions to organizations (apart from those which apply generally) are identified and developed.

The application of ideas of constructivism, autopoiesis, and cybernetic epistemology to the explanation and ontogenesis of work organizations is begun here by constructing a general overview of work organizations as social systems and introducing the broader implications of this characterization. In this view organizations are social systems which are constituted of processes of self-organization, and therefore cannot be characterized in terms of their features, but must be understood in terms of the processes which realize them. The epistemology of the observer as the inventor of his own reality entreats a view of organizations as social constructions whereby all things done in an organization occur through the actions of people and are bound up in the meanings that people attach to them.

In a second-order cybernetic or constructivist view of work organizations, the role of the observer is a key explanatory principle. Distinctions in language are

fundamental to the creation of consensual domains through processes of structural coupling, and thus members couple to the medium (called organization) through relationships in conversation. The organization arises through the languaging of its observer-members. Several observers who are in a consensual domain regarding the existence and qualities of a particular organizational system bring it forth in their reality. Observers might be in consensus about a single goal or purpose and how the organization goes about drawing its resources together toward the stated purpose. They might use any number of constructs, including those present in the domain of organizational science, to explain or inform their activities. However, all distinctions regarding a system including its identity are constructions. Although a formal organization with a stated purpose may be defined in a metadomain of description, each member of the organization constructs a uniquely distinctive organizational reality based on his or her own invented reality. Thus there is no objective organization apart from what is brought forth in the distinctions of observers, even though there would be enough overlap and coordination among observers to bring forth the system as an entity in a consensual domain.

Because the distinctions that we make in our conversations become part of our environment (as we construct it), for the observer in the organization such distinctions recursively create the reality that they

describe. This leads to recurrent patterns of interaction or eigenstates. As observers who operate in language, organizational members will necessarily generate semantic descriptions in which meanings are imputed to behavior. This is the case when members' actions are seen as serving a purpose. But since members are closed systems, distinction of purposes and semantic descriptions are descriptive of the observer rather than the observed system; since everything said is said by someone, all distinctions are political. Thus everyone is responsible for their own distinctions whether or not a claim of objectivity is made.

As organizationally closed systems, work organizations arise in a linguistic domain that is intrinsically non-informative. Thus, while they are thermodynamically and materially open and therefore dependent on the importation of energy for survival, their organization cannot be understood with first order cybernetic concepts such as information, control, inputs, or outputs. To the extent that open systems models are drawn upon to explain organization, they will deflect attention from phenomena which are essentially bound up in closed recursive processes and hence will generate explanatory principles which are deficient. This, of course, contradicts the assertions of most prominent theorists and writers that organizations can only be understood as open systems (e.g. Burke, 1982).

Organizations as Autopoietic Systems

There is a debate whether or not social systems are autopoietic. Even Maturana and Varela, two originators of the theory of autopoiesis, are not in agreement about this matter. Of course this issue is germane to the consideration of work organizations as autopoietic systems, particularly when they are viewed as components of a composite unity, raising questions about the nature of structural coupling of social systems with each other. While it is beyond the scope of this discussion to sort out the complex arguments surrounding this issue, it is worth noting the implications which are key to the consideration of organizations as autopoietic systems.

Maturana and Varela (1980) introduce the concept of second and third order autopoietic systems as those which are generated through the coupling of autopoietic unities. Such a system may appear autopoietic to an observer, because its identity depends on the autopoiesis of the components of which it is comprised. Thus a work organization would be seen as autopoietic because its identity depends on the autopoiesis of its members. Indeed it would be a higher order autopoietic system to the extent that it is defined by relations of production that generate these relations, otherwise an observer who is claiming that it is autopoietic is incorrect. Even though work organizations do not have physical boundaries this does not preclude them from being autopoietic. While

a unity can be easily distinguished when it is bound by a physical membrane, it can also be distinguished as a conceptual process in the domain of "discourse and description." Work organizations are characterized by the latter, and exist in a domain which is different from the domain in which its members retain their identity.

If it is not difficult for an observer to mistakenly misidentify an autopoietic system with a physical boundary, to arrive at a correct determination of autopoiesis in a system without a physical boundary involves even more complex and elusive considerations. To demonstrate that work organizations are autopoietic we would need to show that they meet the criteria for autopoiesis. Stafford Beer (1980) has concluded that many social systems, including work organizations, are indeed autopoietic because they survive, their "method of survival answers the autopoietic criteria, and because [they can change their] entire appearance and ...apparent purpose in the process" (p. 70). Further, Beer asserts that a social system "has identity in the biological sense: it is not just the random assemblage of interested parties that it is thought to be" (p. 71).

Weekes (1984) has conceptualized work organizations as autopoietic systems, suggesting that (using the statement of Jantsch) "they should be perceived as a set of coherent, evolving, interactive processes which are only temporarily manifest in globally stable structures",

rather than as a "specific spatio temperal structure, a changing configuration of components, or sets of internal or external relations" (p. 56). This definition stresses the ephemeral and dynamic nature of the organization that is brought forth and exists through the structural co-drift of its members. When we speak of an organization as something other than the processes which define it (for example, as a structure which persists in space and time), we reveal our operation as observers who "re-present" our sensorimotor experience and create the experience of something constant that exists independent of the observer. Thus what is distinguished by an observer as "the organization" can be characterized as an eigenvalue produced by a continuous sequence of recursive operations.

While an organizational social system occurs within a particular context defined by the conditions in the organizational medium in which members structurally couple, it arises as a function of processes of organizational closure rather than through rational design. Thus the social system defines itself automatically even though certain formal distinctions may reside in an organizational design which contextualizes the autopoietic functioning of observers coupled to a medium. While a rational design may result in the introduction of certain conversations and perturbations into the medium that members will need to contend with, such a design does not instructively interact with members

whose own behavior is structurally determined and unpredictable. Consequently it is hard to imagine an organizational social system as anything but autopoietic. On the other hand, the technological arrangements, which typically derive from some kind of plan result in analytically determinable and predictable systems which are allopoietic.

Indeed it would be possible for the social system at any level of recursion in an organization to be autopoietic. To the extent that they produce themselves, the entire organization and any of its contained systems are autopoietic (Beer, 1981). We can be fairly certain that work organizations are autopoietic in some respects since the individuals which comprise them are membrane-bound autopoietic systems, and consequently the functional processes operating in the medium cannot be accurately characterized in a manner inconsistent with this fact. In the operation of "producing itself" a social system operates as a system whose identity arises in the third-order structural coupling in language of its members. To another observer a contained system in the context of a larger system, say a department in a factory, may appear as an allopoietic component, the purpose of which is to support a larger system. However if the contained system has an identity as an autonomous system, it is autopoietic. It can be described in relation to its purpose in a larger system, but this is not the relation

which describes its internal dynamics. Thus a logical accounting must be maintained in order to appreciate the autopoiesis of contained systems. When we fail to do this, we misunderstand the system's internal dynamics.

A work organization as an autopoietic system could be further described as an aggregate of organizationally closed structurally coupled unities which define a consensual domain and can be distinguished by an observer at different levels of recursion. The coherence in the interactions between members arises through their structural plasticity which allows them to converge along a path of co-ontogeny as defined in their linguistic operation. The identity of a work organization depends on conservation of adaptation of its members both as individuals and as members of the linguistic domain in which the organization is defined. Further, if the identity of the work organization is to remain invariant, so must its organization, although its structure can change. Thus the organization does not disintegrate when members are replaced and can have many different forms. Each member of the organization is moving along a path of its own autopoiesis and therefore will structurally couple no more than what is possible within the range of its own autopoiesis. Each member has other dimensions of structural coupling that are irrelevant with respect to the medium defined by the work organization.

The Organization and the Observer

The previous overview portends a significant shift in the way organizations are conceptualized. The ontology of living systems, including the epistemological status of the observer has considerable bearing on organizational theory and praxis. Peter Vaill's previously mentioned lament of the lack of theories to help explain language and consciousness, thinking processes, and competing definitions of reality is addressed in a very fundamental manner.

A consideration of the significance of these ideas to the understanding of work organizations is anticipated to project beyond mechanical and organismic metaphors toward a new comprehension of the complex patterns of human activity that comprise "organization".

Cybernetics

The shift in the nature of descriptions of work organizations when we define them in terms of the processes that realize them is expressed in Ernst von Glasersfeld's (1985) distinction between the two major orientations of cybernetics: "One is concerned with the conception and design of a technology based on mechanisms of self-regulation by means of feedback and circular casuality. Among its results are industrial robots, automatic pilots, all sorts of other automata, and computers" (p. 9). Von Glasersfeld indicates that it is this "practical orientation," which is associated with

management theory, that "has elaborated principles that clarify and systematize the relations between the controller and the controlled, the government and the governed, so that today there is a basis of well defined theories of regulations and control" (p. 9). The other approach focuses on the question of knowledge and self organization in living systems and places the status of objectivity within the recursive relationship between observer and observed. It is this latter notion of cybernetics, which is embodied in Bateson's "cybernetic epistemology", von Foerster's constructivism, and Maturana and Varela's autopoiesis, and its many implications which are of concern here. When we describe organizations in this way we characterize them as members of the class of human social phenomena, the analysis of which must be based on an understanding of the processes of structural coupling of individuals in "linguistic domains, where they (the components) can operate with language and be observers" (Maturana & Varela, 1988, p. 198).

The distinction between first and second order cybernetics expresses the fundamental difference between the two views. The former views systems as material entities, examining them in terms of "regulation, computation, ordering and entropy retardation" (Von Foerster, 1972b, p. 209). Many metaphors of organization fit into this view, or at least have the same general form. A second-order cybernetic view differs

fundamentally from most of these by embodying a different epistemology - one which includes the description of the observer in the description. Consequently, a description of organizational functioning is a statement about the describer's epistemology, or way of knowing and constructing a description of an organization. This represents an expanded phenomenal domain in which we can consider either the simple description or the observer and his description as recursively connected elements occurring at different orders of analysis. Once a higher order of analysis has been introduced and its significance is recognized, we can hardly dismiss these newly discerned phenomena. To do so is to accept that an objective world exists apart from the observer. Further, we would miss the significance of organizational closure and fail to see the recursive functionals that describe the self-referential nature of living systems.

Constructivism and organizational closure are important with regard to the phenomena proper to work organizations as social systems as well as the phenomena relating to observers operating in the theoretic domain constructing theories about work organizations. Whether an observer is operating in a domain of explanation or is a member of a work organization, he operates in a similar fashion - making distinctions, bringing forth realities, and living in social sytems.

Domains of Explanation

In the domain of theoretical explanation the constructivist perspective has considerable heuristic potential in reference to both the theorist operating as an observer-member of a scientific community and the efficacy of the theoretical explanations which are produced by such observers. A second-order cybernetics view prevents us from disconnecting the latter from the former; the distinctions which are drawn reflect the operation of the observer-theorist in his medium. When theorists look for objectively valid descriptions and explanations they tacitly violate the constructivist epistemology and neglect to consider the inseparability of the purposes and identities of the observer from his distinctions. The importance of considering the nature of the observer in organizations was raised several years ago by Baritz (1960) in his book The servants of power in which the nature of interventions in organizations was revealed to be clearly subserviant to the interests of selected observers, although they were seen to be based on accepted theory. The integrative potential of constructivism lies in the inclusion of the recognition of the characteristics of the observer in the consideration of his distinctions.

Much of the contradiction and paradox that exists in organizational theory is clarified when constructs are seen to arise from a multiverse of observers. The polemic

issued by organizational theorists debating the relative truth of their preferred theories loses its urgency when the search for truth is replaced with the search for consensus inherent in the position that all distinctions which comprise the domain of theoretical explanation must be seen as constructions. While this position does not appear to be widely subscribed to in the organizational literature, social constructivism does have some representation. For example, Astley (1985) has put forth a view of organizational science as socially constructed truth. This writer states that "Perhaps an explicit awarenesss of the socially constructed nature of knowledge may encourage a more liberated view of scientific progress" (p. 511), a statement which is congruent with the spirit of this current exploration.

The vast literature on leadership exemplifies the search for absolute explanations of the effectiveness of the behavior of leaders. This literature usually does not contextualize its explanations in reference to the logic of the describer who is often interested primarily in securing the compliance of the subordinates. A recent article by Hornstein, Heilman, Mone, & Tartell (1987) is a rare example of the recognition of the importance of the role of the observer in determining the outcome of research into leadership effectiveness. Essentially these authors describe the different punctuation of events that occurs with different judges. Superiors rate

effectiveness against a criteria of compliance whereas subordinates are more interested in good relationships. This study demonstrates how three prominent contingency leadership models (Hersey & Blanchard's situational leadership model, House's path-goal theory, and Vroom & Yetton's leadership decision-making model) which, in neglecting to consider the logic of the describer, generate insufficient explanations. Thus the question, "What is an effective leader?" can be answered only in reference to the intent and perspective of the observer who is asking it.

The same analysis could be applied to any number of theoretic constructs in the domain of organizational theory. The epistemological adjustment required by autopoiesis frames all concepts such as control, regulation, information, the identification of a system, or leadership and motivation as distinctions or explanatory principles invoked by an observer that resides in the metadomain of description rather than reflecting the thing-as-such. However, to the extent that such observer distinctions are viewed as truths and violate the ontology of living systems, rather than expanding the understanding of work organizations they will countenance fundamental misconceptions which fail to regard the functional processes underlying self-organizing systems.

If the theory which is invented by observers is to reflect a correct ontology, in its observations it must

account for the epistemological status of the observer. Theories which do not meet this requirement are essentially deficient explanatory principles which cannot elucidate processes of organization. For example when organizations are described with the terms of Newtonian mechanics or first-order cybernetics, the distinctions of control, information, cause and effect, input and output are not descriptive of the ontology of living systems to the extent that they are seen as reified concepts rather than constructions of observers. To characterize organizations as living systems implies that the circularity of the organization of systems must take primacy over the distinctions that arise through the operation of the systems. Otherwise our explanations are stuck in the realm in which our distinctions exist as though they are disconnected from their inventors. In this realm we fail to see that "the logic of the description is the logic of the describer" (von Foerster in Segal, 1986, p. 75), and fall into the causal and lineal explanations that arise from the deceptive processes of language.

Ontogenesis

A second-order cybernetic perspective of the ontogenesis of work organizations allows us to see the correspondence between the dynamic patterns of interaction that sustain the system's organization and the operations of distinction of an observer that brings it forth. That

is, we can appreciate that internal coherences arise through the recursive generation of the realities expressed in the distinctions of observers. To define the organization in terms of certain qualities or dynamics is to introduce them into the medium as perturbations and recursively bring them into play in support of themselves as a form of eigenstate.

The concept of "enactment" as formulated by Weick (1979) focusses on a characterization of circular organizing processes (apart from any reference to autopoiesis) that is similar to the concept of recursive generation. This term refers to the process in organizations whereby actors produce occurrences through ongoing sequences of interaction, eventually creating an environment which in turn imposes on them. Weick cites a statement of Geertz that eloquently expresses the circularity of generative language: "man is an animal suspended in webs of significance he himself has spun" (p. 135).

The epistemology of the observer is a factor in this process because it corresponds to the nature of the distinction that the observer draws. While we adopt habitual ways of knowing over the course of our own ontogenies, we are blind to our own closure. Consequently we apply our own punctuation to events without an awareness that we are describing a self-validating reality; our "mind-sets" produce distinctions that

validate our mind-sets in a way in which we are unaware. This is the case when observers draw theoretical distinctions and when observers who are members of organizations draw distinctions about the system of which they are part that become part of the medium of the organization. Thus an observer draws a distinction on the basis of a personal epistemology and makes a description which is introduced to the medium where it is experienced as a perturbation by other observers.

Many different conditions can arise in organizations through this process. Consequently, the prevailing theories of organizational members can have considerable practical consequences to the extent that they become part of the conversations that inform the actions of members and generate certain conditions in the social medium.

In the organizational literature, Argyris (1979) has written about a similar concept. He coined the term "theory-in-use" to refer to the cognitive "maps" which are the basis for people's behavior and which give rise to certain "behavioral strategies" in organizations. Argyris writes about two theories-in-use (Model I and II) which represent different "governing variables" and "behavioral strategies", but does not make use of recursive function theory or concepts of organizational closure to explain the generative operation of theories-in-use.

The conditions which arise in organizations presumably could reflect a full spectrum of theories-in-

use. Conditions could arise in connection with certain formalized relatively enduring structural features such as roles, work-flow and job-design arrangements, budgeting systems, human resource systems such as salary and performance review, department groupings, and so on. In addition we might consider conditions associated with the notion of "Psychological Climate" in organizations such as those outlined by James, Joyce, and Slocum (1988, p. 129): "a. conflict and ambiguity; b. job challenge, importance, and variety; c. leader facilitation and support; d. work group cooperation, friendliness, and warmth; and e. professional and organizational esprit."

In addition to these relatively "static" conditions, there are those which arise through the dynamic interactions of individual observers who act on the basis of their own epistemologies, and are manifested in the nature of the relationships between individuals. For example these interactions could reflect "complementary" or "symmetrical" relationship patterns as outlined by Bateson. There is no doubt a recursive relationship between the enduring, relatively static features of organizations and the nature of the ongoing relationships between individuals, whereby they become mutually supporting. Both are related to the "habitual ways of knowing" of the observers who make distinctions and introduce perturbations into the medium. For example particular organizational features and the day-to-day

conversations of an individual might both reflect a belief in instructive interaction.

The conditions that arise in the social medium of the organization describe a context within which individuals act and continuously bring forth an organizational reality in interaction with other observer-members. Thus the quality of the structural coupling of individuals to the medium could be either enriched or impoverished. This is an important factor with regard to the coherence of the organization of the system which depends on the ongoing interactions between members and the existence of a consensual domain.

Lawrence (1987) reports that in a recent workshop Maturana has clarified his explanation of consensuality as it relates to structural coupling. He describes three levels of consensus, the first of which is the fundamental coherence among people in society who may briefly encounter one another but do not engage in recurrent coordinations of action. The second level involves recurrent coordinations of language or action, but this does not imply agreement. It could include a situation in which there are ongoing interactional patterns between two individuals that might be characterized as indifferent or even destructive. An example would be a complementary relationship such as dominance/submission. The third level of consensus involves agreement. Lawrence has modified Maturana's definition of agreement to describe a

level of coordinated action that could be described as "very good communication: or a "close bond" (p. 234).

Lawrence's definition is useful in the discussion of work organizations because it, in concert with Maturana's formulation, allows us to distinguish three different conditions with respect to work organizations. We can consider which of these three conditions might be associated with particular theories-in-use or epistemologies. From the perspective of seeing organizations as autopoietic systems it is possible that each of these conditions might be seen as desirable in appropriate circumstances. Clearly though there are many situations in which the condition of agreement will best serve the autopoiesis of both the individual and the larger system. The internal organization of the system will in many cases be better able to maintain adaptation with consensual agreement. This is because the coherences that describe the patterns of interactions between members are characterized by ongoing structural adaptations which take the form of "coordinations of conduct". The second level of consensus describes a different kind of coherence - one which could be characterized by dysfunctional interactions which can lead to a breakdown in structural coupling.

From the perspective of an expanded phenomenological domain we as observers can consider the significance that a distinction between first- and second-order cybernetics

has to the nature of the system that is brought forth. An observer can distinguish a system as either autonomous and organizationally closed or in terms of inputs and outputs. A description of the operation of a system in terms of input and output is a first-order cybernetic description - what Bateson termed a "partial arc" of a larger circuit. What is contained in the larger circuit is that the first-order cybernetic description expresses a relationship between the observer and the system being observed. The first-order cybernetic explanation misses the imperative of many other possible punctuations arising from other observers with different relationships to the system being observed; it fails to comprehend the nature of the organization as a larger circuit and the recursive closure between description and describer.

An explanation which does not include the epistemological status of the observer tacitly assumes that an objective reality is being described and misses the self-referential and organizationally closed nature of the system. Keeney (1983) indicates that, while simple cybernetics explain the coherences in observed systems, second-order cybernetics allow us to discern coherences of coherences. Thus the coherences that arise in descriptions are recursively related to the coherence that exists between the describer and his description. When an observer defines a pattern of control in what he defines as a first-order cybernetic pattern of organization, he is

describing a coherence in the system that he "sees". A second-order cybernetician can see the coherences in the observer bringing forth a pattern of coherence, or a coherence of coherence. This is the coherence between what the observer "sees" and what he "looks for" and is a coherence which continually validates itself.

This, of course, is also the case for an observer who adopts a second-order cybernetic perspective and sees limitations in a first-order cybernetic view. The deficiencies we identify validate the distinctions that we make in order to distinguish the deficiencies. From this epistemological vantage point we can describe how an observer who is aware of the larger circuit can consider a partial arc, but not the reverse. Hence a second-order cybernetic perspective can include in its consideration both first- and second-order cybernetic phenomena. A first-order cybernetic epistemology is blind to the larger circuit even though it unknowingly arises through second-order cybernetic processes.

When we examine the notion of "purpose" from a second-order cybernetic perspective, we can describe a "larger circuit" which is invisible from a first-order cybernetic perspective. The "dispensability of teleonomy" is one implication of autopoiesis that runs counter to current organizational theory. It would indeed be seen as outrageous to suggest that a work organization is not defined primarily through its commercial purpose.

Maturana and Varela (1980) maintain that notions of purpose and function are not necessary for the understanding of the organization, but are observer descriptions of the system that reflect the observer considering the system in an "encompassing context". That is, an observer creates circumstances in which the unity is put to use, thereby creating a context in which the observer can define inputs, outputs, purpose, and function. Thus while a work organization or one of its members could be defined in the context created by an observer as having purpose or function, the relations implied in these notions "are not constitutive of the organization of an autopoietic system, [and] cannot be used to explain its operation" (Maturana & Varela, 1980, p. 86). This is something that is visible only from a second-order perspective . Thus a first-order cybernetic view would not see that "purpose" is not constitutive of the organization of systems. To the extent that work organizations are autopoietic systems the distinctions of purpose and function are like epiphenomena which are of no consequence to the explanation of the operation of the system. Maturana and Varela (1980) indicate that they "have no explanatory value in the phenomenological domain which they pretend to illuminate, because they do not refer to processes indeed operating in the generation of any of its phenomena" (p. 86).

Work organizations and their members are therefore purposeless systems; their only purpose is to maintain their own autopoiesis. How then do we account for the stated raison d'etre of work organizations? Peter Drucker (1988), an icon of organizational behavior, posits that "the result of a business is a satisfied customer. The result of a hospital is healed patient. The result of a school is a student who has learned something" (p. 76). Autopoietic theory would say that the purpose of all of these organizations is to maintain their identity and continue in their autopoiesis. Thus while satisfied customers, healed patients, and students who have learned something are results of organizations, they are not its purpose. Observers can become oriented toward a particular domain of thought through notions of purpose and function (indeed this is an imperative of their linguistic operation in a consensual domain), but these are not the purpose of the organization or its members. These belong to a domain of semantic explanation rather than the domain of operation of the system. Keeney (1983) indicates that the former refers to the relationship between the observer (who is distinguishing the purpose) and the system being observed. When we confuse the domain of semantic description with the domain of operations we are neglecting to keep our logical accounting in order.

If this seems a rarified notion, the literature on power in organizations provides more palpable treatment of the nature of purpose. For example we have the Law of Political Entropy, which states that "given the opportunity, an organization will tend to seek and maintain political character" (Pfeffer, 1981, p. 32). This "law" communicates the importance of political interest in organizational decision making, recognizing that the pursuit of political identity can often render over-arching goals and purposes irrelevant in the operation of the organization. Seasoned and imaginative organizational development practitioners cannot help but become aware that organizations usually make more sense when viewed in terms of the members' interests rather than their charter or mission. Can anybody who has dealt at length with a hospital not see how the procedures and routines often make less sense in the context of the autopoiesis of the individual patient than in the context of the autopoiesis of the institution and its stakeholders?

Thus when we confuse the domain of semantic description with the domain of operations we are neglecting to keep our logical accounting in order. The domain of semantic explanation refers to the relationship between the observer who is distinguishing the purpose and the system being observed. However, because of the experience of objectivity and its embodiment in language

structures, the observer does not see that his descriptions represent his relationship to the system and not the "thing as such."

Organizations are no doubt brought forth from many perspectives and can be described with a variety of metaphors. If we consider only two classes of metaphor, a common first-order cybernetic, and second-order cybernetic, we can imagine that the organizations that are brought forth from these two premises will result in different conditions that will describe two very different coherences. These coherences will, to a greater or lesser extent support continued adaptation of the system or begin a path toward disintegration. Conditions which contribute to disintegration can be said to constitute impairment or pathology in the system.

From a second-order cybernetic perspective we can explain how a system built on the premises of a first-order cybernetic epistemology can be defined as an impaired or pathological system. It can be seen as a coherence whereby a deficient epistemology creates a deficient system. We can examine the conditions that arise in these systems, assess them in light of the processes of structural coupling of individuals in consensual domains where they operate as observers, and determine if this impairs or facilitates the conservation of adaptation and organization of the system. We can also explain how a system built on the premise that it and its

observer members are autopoietic systems defines a healthy organization. These two epistemologies are associated with very different explanations of the phenomena that are important to the coherence of the organization of the system, and thus correspond to very different dynamic patterns of interaction.

When a system is defined in terms of its purpose the coherence of the system is often framed in terms of enforced mechanisms of constraint. An organization built on this premise arises through a logical misaccounting and describes a "partial arc". Impairment can result from misapprehending the nature of the operation of living systems.

When an organization is built on the premise that its purpose is to maintain its organization and conserve adaptation a very different coherence is defined. This kind of coherence is concerned with the creation of identity in consensual domains within which individuals and groups orient their actions based on processes of structural coupling in language. It encourages a wider range of choices to increase the capacity for internal state change. Finally, it is concerned with the process that enables the system to operate in a way that allows it to continue to operate; it describes a systemic rather than a lineal coherence.

Generating Pathological Systems

The basic condition for pathology in systems is a belief in objectivity and the many corollaries of the belief that are reflected in a first-order cybernetic epistemology. It is from this perspective that an observer defines an organization in terms of a summum bonum, a single good. This is the consequence of language structures obfuscating the difference between the semantic domain and the domain in which unities operate so that an observer sees a lineal sequence of events leading to his defined goal. He does not see the systemic consequences that his lineal description has for the process that enables the system to operate in a way that allows it to continue to operate. Thus he is confused when the determinants he has defined as critical to the functioning of the organization toward certain defined ends appear to be in order but the organization is not. In this case, to the extent that the coherence of an organization is seen to depend on conditions which do not describe the operation of unities as autopoietic systems, the coherence which is described is not systemic - it is a partial arc.

There is little doubt that this model of coherence is prevalent in contemporary organizations in spite of the recent spate of descriptions of "innovative" approaches to organization that eschew the so-called "traditional" approach. In order to explicate this lineal model of coherence we can consider a quintessential traditional

organization as a combination of Frederic Taylor's "scientific management" and Max Weber's "bureaucracy". This approach would essentially be concerned with adapting man to the system. It would focus on securing the compliance of lower members to the directives of higher members through the application of external control, negative sanctions, and external reward (rather than intrinsic reward) (Katz & Kahn, 1978). The approach to control would focus on minimizing individual differences and result in standardization and rigidification of work (Lawler, 1976). These organizations would seek to maximize productivity through focussing on the control of strict coordination of tasks which require workers to maintain rigid work schedules, high levels of concentration, close timing, and mechanical implementation of orders (McNeil, 1978). The approach to the design of organizational structures would follow the tenets of the "scientific management" school (Agryris, 1964), which would emphasize a high degree of external specification and control of work methods. Division of work, unity of command, span of control, and subordinating the interests of the individual to those of organization are other related principles (Ullrich & Wieland, 1980), which focus on the mechanics of task coordination and attempt to place the control of work in the hands of non-worker decision makers. This description is consistent with MacGregor's well-known theory X assumptions (MacGregor, 1984).

MacGregor has argued that theory X assumptions lead to the traditional models of direction and control in organizations, and further, that these assumptions are revealed in most mangement efforts.

While most of us would like to believe that this description of a traditional organization is extreme and outdated, and indeed it may be with respect to specific terminology, the model of coherence that it is based on is much in evidence in both theory and practice. Invariance and predictability are generally seen to arise through a process of control. For example, Tannenbaum (1968) indicates that "The coordination and order created out of the diverse interests and potentially diffuse behaviors of members is largely a function of control" (p. 3). "Organization implies control" (McMahon & Ivancevich, 1976, p. 66) is a statement which underscores the salience of a belief in the importance of control in organizations. This model of coherence is implicit in a broad range of organizational processes from leadership to strategic planning.

It is not difficult to understand how this model could become prevalent in organizations; it represents a view from the top. A top manager who operates with a firt-order cybernetic epistemology does not see that his descriptions express his relationship to the system he is describing and that the logic of the describers and the description are inseparable. When he designs the

structure and processes of the organization it is on the basis of his epistemology as it is expressed in his assumptions about system coherence. The interactions between component unities are seen to be determined by the transfer of control down the hierarchy which is defined in terms of enforced mechanisms of constraint. The intent is to produce a narrow range of activity under the control of management.

This model of coherence, which arises from the assertion of one legitimate reality, depends on instructive interaction and the treatment of embedded systems as trivial machines. These are seen to be the fundamental determinants of behaviors and interactions in a system which defines its organization as functioning toward producing output. Such systems are impaired because they do not recognize that "human social systems require components structurally coupled in linguistic domains, where they (the components) can operate with language and be observers" (Maturana & Varela, 1987, p. 198). Furthermore, while an organism requires operational stability of its components, a social system "amplifies the individual creativity of its components, as that system exists for these components. - Coherence and harmony in relations and interactions between members of a human social system are due to the coherence and harmony of their growth in it, in an ongoing social learning which their own social (linguistic) operation defines and which

is possible thanks to the genetic and ontogenetic processes that permit structural plasticity of the members" (p. 199). Consequently, social systems which restrict the behavior of their members are impaired. The traditional organization to some degreee tries to restrict the range of behavior and quell the operation of individuals as observers by specifying the interactions in the system. In order for this to succeed it would need to completely undermine our operation in language and the bringing forth of consensual domains.

Thus we can see how impairment can arise from the treatment of structure-determined closed systems as trivial machines whose output is determined by the input. We can also imagine how the assumption of instructive-interaction could lead to structural adaptations that were not predicted. If control is the sine qua non of the traditional organization it is understandable how this model of coherence leads to system deficiencies. Since organizations are autopoietic and the systems therein behave in accordance with the dynamic processes of autopoietic systems, the treatment of a composite unity and its embedded systems in a manner which is epistemologically erroneous could give rise to pathological interactions which will downgrade the potential richness of the structural coupling of autopoietic unities to the medium, and ultimately downgrade the composite unity. Bateson postulated that a

belief in objectivity, actions which are contrary to the circuitry of a system, and attempts to control the system are the roots of psychopathology (Dell, 1985). Similarly, a belief in instructive interaction, control, hierarchy, and other expressions of a misunderstanding of the phenomena of cognition (i.e., that the experience of objectivity is constitutive of an independent reality) or the application of the cybernetics of automata to living systems could lead to pathological manifestations in the ontogenesis of work organizations.

As the recurrent interactions in organizations are recursively related, an organization becomes the distinctions that it defines and thus a pathological system defines itself through its pathology. As explained by Mendez, Coddou, and Maturana (1986), the organization of the system is realized by the "configuration of relations and interactions between the components" (p. 24). When operating in accordance with the epistemology of living systems, interactions can take the form of "coordination of actions" (p. 25), but otherwise they will come to define pathological interaction (e.g. in families these might be accusations or recriminations). Stated another way, the closed system of recursive interaction can realize a pathological eigenstate. If the degree of pathology of the system prevents the continuation of autopoiesis, the system's organization disintegrates, while a lesser degree of pathology could reduce the

fecundity of structural coupling thereby limiting the coordination of actions of the organization.

An observer who defines a system can assign it a unifying purpose and focus only on those structural components which are necessary to that particular definition. The system could be conceptualized as an open system in order to draw attention to aspects of "openness" such as energy exchange with the environment and the specification of inputs and outputs in a manner that directs efforts toward a defined purpose. In addition, the invention of hierarchy, the characterization of components as trivial machines, and the use of the language of pleroma might be evident. However, if these distinctions are not treated as fictions and fail to consider unities as autopoietic structure determined systems, they are epistemologically erroneous and hence do not explain the determination of behavior of system. This would be the case at any level of observer distinction.

Epistemological errors can take many forms as can the pathological interactions that realize the ontogenesis of the organization. Most of these regress to a failure to distinguish that the experience of reality is a function of the recursive interaction of observer and observed; that is, there is a belief in objectivity wherein what is cognized is seen as constitutive of an independent reality. Maturana would say that this is a failure to put

objectivity in parentheses (Simon, 1985). The denial or constraint of the autopoiesis of composite unities and embedded systems occurs when an observer defines notions such as hierarchic subordination or the reification of a larger system with an assigned purpose as though they constitute an objective reality, thus allowing an observer to introduce perturbation into the medium on the basis of the notion of instructive interaction.

Patterns of interactions within such systems that are based on a belief in objectivity deny the existence of many realities. Thus, each individual experiences his or her set of constructions as an objective universe, "and, accordingly, lives the interactions through which he or she constitutes it in terms of assessments that imply a grasp on an absolute reality: 'I am right, you are wrong'" (Mendez, Coddou, & Maturana, 1986, p.23). Thus the consequence of not placing objectivity in parentheses is to deny the legitimacy of different domains of existence, which results in a closed network of interactions within which negative mutual characterizations result (Mendez, Coddou, & Maturana, 1986). Pathological manifestations would arise from the failure to recognize that individuals structurally coupled with the medium (which contains other individuals) in a manner which triggers structural adaptations which are unpredictable. Formal systems can be introduced into the medium that treat component unities as though they relate to the medium instructively rather

than interactively. Failure of the component to behave predictably could be attributed by an observer to weak motivation or some other explanatory principle which ignores difficulties in the formal medium and does not recognize that the organization was generated by factors which realize negative eigenstates. Usually the worker is fired rather than system deficiencies changed.

Thus when policies, procedures, reward systems, performance appraisals, reporting structures, leadership processes, etc. are designed in accordance with notions of instructive interaction, the result could be that they comprise a structural configuration of the medium that will generate a closed network of pathological interactions or the disintegration of the organization. Since the actual perturbations that take place are determined by the structure of the medium, the state of the medium must permit the unity to continue in its autopoiesis in order for structural coupling and coordination of conduct to occur. Consequently, in order for a person to couple with an organization, the organization must be configured in a manner which will allow the autopoiesis of that person to continue (i.e., does not negate the identity of unities by invoking objectivity).

Even though social systems are embedded in larger systems recursively and all of these systems are autopoietic (Beer, 1980), a failure to place objectivity

in parentheses allows the embedded system to be viewed as less than autopoietic, particularly by observers who have authority in the organization. In a reified system with a single defined purpose, individuals in authority are defined by the system as holding responsibility for defining the system. Thus, an eigenstate is recursively constructed wherein the person in authority defines objectivity for the system. In the domain of description from the perspective of the defined system, the embedded system can be seen to be regulated and controlled; the observer would see the system at their level of recursion as autopoietic but treat other levels of recursion as allopoietic. Furthermore, a "claim to objective knowledge is an absolute demand for obedience" (Mendez, Coddou, & Maturana, 1986, p. 42). Heinz von Foerster indicates that "objectivity is a subject's delusion that observing can be done without him. Invoking objectivity is abrogating responsibility, hence its popularity" (von Glasersfeld, 1985, p. 10).

It is not difficult to imagine a senior manager's belief in instructive interaction and the manifestation of this belief in various control measures. Nor is it difficult to imagine a rank and file member's view of these measures as inevitable hurdles. The worker's reluctance and the manager's escalation of control efforts may reflect structural adaptations of one to the other within a closed interaction of negative characterizations.

As Weick (1979) indicates, "calculation" or "intent" usually originate at the top and reflect "an expedient set of alliances composed for the ultimate purpose of gaining control" (p. 20). Since this perception does not characterize the interaction of the components, it has the consequence of treating the contained system as though it is not autopoietic, and thus the system must now respond to that constraint. Of course, this sequence could be inversely punctuated also. The attempt to tightly control and highly specify the behaviors of people (i.e., to treat them as trivial machines) may result in structural adaptations that were not envisaged.

A recent news item quoted a memo written by a human resources manager of a pulp and paper plant:

> With the aim of instilling a work ethic within St. Marys Paper Inc., we feel that the reading of newspapers, pocket novels and the playing of cards on paid coffee and lunch breaks, are not conducive to the success of our operation.1

Obviously, the manager who wrote this believes that controlling what people read will result in the instillation of a work ethic; he believes in instructive interaction. A likely impact however, is that this distinction will make it difficult for employees to structurally couple with the organization as a medium (if

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1 from Edmonton Journal, Sunday, August 17, 1986

it is configured in a manner suggested by the tenor of this memo) and still continue in their autopoiesis. Thus, the result of the memo may well be a decrease in what is defined in the domain of description of the manager as work ethic (which is what Bateson would term a "dormitive principle"). That is, the manager could well find a decrease in the behavior that he distinguishes as work ethic, even though a worker would likely interpret this differently. The human resources manager did perturb some interesting structural changes - but not those intended. Therefore the perturbation was not instructive.

Bureaucratic behavior, work-to-rule, setting production volumes at comfortable levels are ways in which individuals might structurally couple with an organizational medium in a fashion which ensures the continuation of autopoiesis, even though limiting the coordination of conduct in the medium. Other common occurrences might be the withdrawal of commitment or concern as a way of specifying which structural configuration of the medium in which it operates may perturb it. When clockwork functioning does result, it may be attributed to rational management processes, rather than effective structural coupling between unities moving along a path of their own autopoiesis. The discretionary behaviors of individuals may not be distinguished by an observer.

This lineal model of coherence could also be manifested in descriptions of the nature of "leadership". "Leadership" would actually constitute a nominalization which entices us to forget that it describes a process. Leadership is an important topic to any discussion of organization of work systems because it is commonly used as an explanatory principle for a broad range of events in organizations. This is likely because distinctions such as control and hierarchy are often seen to be enacted primarily through leadership which is therefore critical to the explanation of the relationship between levels. Leadership can be viewed as a convenient catch-all explanation for events in organizations that have not been otherwise convincingly explained. When it is framed as a lineal process of control, what is lost is an appreciation that it describes something happening between people and thus represents a static model failing to describe or prescribe an interactive process. That is, these models cannot describe the ongoing structural adaptations of a closed interactional system. Static notions which represent one level of observer distinction do not have meaning in the context of a closed interaction at a different level of observer distinction. Leadership models reflect an observer's particular punctuation of a closed system of interaction, while another observer can have a different punctuation. For example, a senior manager may view leadership as a critical control function

whereby a particular person can be held accountable for certain results, while an underling may view leadership as a relationship with another individual who provides resources and expertise. That is, each might view it in a manner which reflects his own interests.

Many leadership theories frame the actions of leaders as instructive interactions (e.g., Path-Goal theory), when in fact "leaders" can only introduce perturbations into the medium. The assumption of hierarchy and instructive interaction is evident in the popular Situational Leadership model of Hersey and Blanchard, which requires the leader to assess aspects of the decision to be made, including the maturity of the subordinate, and then decide what level of participation the subordinate will have in the decision. Clearly, the autopoiesis of the system at the level of recursion of the leader is served by this model while the subordinate's autopoiesis is denied. Actually, not only is the subordinate denied the opportunity to be involved, but is also told that it is his fault that he has been excluded. Thus, the leader does not even take responsibility for his own distinctions! It is doubtful that the perturbations stemming from this leadership mind-set would result in full coordinations of actions. Clearly this approach is not concerned with establishing consensual domains.

Pathological eigenstates can be distinguished within the interactions of individuals, in the interactions of

other composite unities, and in the interaction between unities inside and outside the organization. Disintegration of the system is the extreme negative eigenstate. Weekes (1985) argues that the failing competitiveness of the western industrial nations is associated with traditional mechanistic views of organizational control inherent in management practices that fail to recognize processes of autopoiesis. Davis (1986) indicates that Three Mile Island and other near disasters are attributable to similar misconceptions about how organizations and people function. On an individual level, various stress reactions may result from treatment which denies the identity of organizational members. There are many possible manifestations of negative eigenstates at different levels of observer distinction in the organization. Recognition that distinctions such as hierarchy and control are ontological fictions, that objectivity is an illusion, and that there are no trivial machines in living systems allows us to explore other possible distinctions. Pathological systems and misguided energies can hopefully be minimized by a better understanding and application of the functional processes underlying autopoietic systems which help to explain why rational plans are not followed and why the actions of individuals sometimes appear conflicting and unrelated.

Generating Autopoietic Systems

If work organizations are autopoietic systems, congruence with the theory of autopoiesis becomes the criteria for examining distinctions to help identify those features and perspectives which enable a system to operate effectively, thus avoiding a breakdown in the dynamic patterns of interaction which sustain the system. Since we cannot specify the interactions of closed systems, people or other closed systems cannot be made to behave in particular ways. They will couple to the medium in a manner determined by their structures. Perturbations in the medium that do not deny the identity of a unity can be part of the structure determined repertoire of the unity, but can only select rather than instruct a response. The immediate consequence of this point is that the effectiveness of organizations, however defined, is due to the structure determined behavior of component unities, not the hierarchic orchestration of concatenations. That is, effectiveness hinges on member's good will and discretionary behaviors which are manifestations of individuals moving along a path of their own autopoiesis.

Work organizations generated in the image of erroneous epistemologies do prosper (by varying definitions). Enough coordination of conduct is present in the phenomenic domain for this to occur, even if in the domain of description most members subscribe to erroneous notions. There can be processes in organizational praxis

that implicitly conform to notions of autopoiesis in spite of varying degrees of incongruence in concomitant formal distinctions. The processes of self-organizing systems endure whether or not they are salient in a domain of description, and a trivial machine or analogous metaphor will not make a living system less autopoietic. But since the organization of the system at different levels of observer distinction is constituted of autopoietic processes, downgraded organization can occur through these same processes when ontogenetic impulses are based on faulty assumptions regarding how organization occurs.

Defining characterizations or prescriptions of how to generate desirable system features is constrained by the implication of radical constructivism that we cannot know an ontological reality; we can only know the constraints of our constructions when they break down in our experiential world. Consequently, a cognitive structure reflects only "one viable way to a goal that we have chosen under specific circumstances in our experiential world. It tells us nothing--and cannot tell us anything--about how many other ways there might be or how that experience that we consider the goal might be connected to a world beyond our experience" (von Glasersfeld, 1984, p. 24). Thus, "all we can even know about the real world is what the world is not" (Watzlawick, 1984, p. 14).

This epistemology influences the approach to defining features which are congruent with the notion of

autopoiesis. It explains why it is much more manageable to identify errors in epistemology at the root of pathology in living systems than to prescribe the operation of a system according to principles of autopoiesis. It is easier to define pathology than health. Furthermore, it suggests that we are epistemologically constrained from seeking absolutes; we can only be prescriptive to the extent that we can say that the ontology of autopoiesis should not be violated and that the ontogenesis of organizations should not be based on faulty epistemologies. It is only through contrast with what the world is not that we can delineate features which appear to be viable and avoid creating a deficient system.

Thus, we can neither dictate favorable interactions nor define an absolute organizational reality and consequently we cannot easily deduce a set of organizational features from a set of principles of autopoiesis. There could be many ways of defining an autopoietic work organization. The focus on establishing a context within which a system functions in terms of the processes that realize it could result in a variety of features and structures. To the extent that an organization is a self-organizing system, it is defined in terms of the processes that realize it, and consequently would develop its own unique state. In this sense an organization is its own manifestation of its own

eigenstate (Vanderwell, personal communication). Its identity is experienced as a stable entity which is generated through a recursive sequence of operations. Consequently when organizations are defined as self-organizing, generalizations from one to the other disregard the fact that each organization has its own manifestation of its own eigenstate that makes it unique. A system must therefore have the ability to generate its own eigenstates through processes of self-organization.

Thus while we cannot prescribe a set of features common to all organizations brought forth as autopoietic systems we can identify issues that are important to their operation as self-organizing systems. The title of this section, "Generating Autopoietic Systems", might be criticized for an apparent internal contradiction in terms. A similar protest might be evoked had this section been entitled "Organizing Self-Organizing Systems". How can we talk about organizing a system that organizes itself? What this title refers to is not the production of self-production, but the recursive act of bringing forth that which is distinguished in language and discourse. The leap from a first- to a second-order cybernetic epistemology allows not only the articulation of this recursive process, but also of similar recursions that underlie the operation of self-organizing systems. Thus as observers who are reflected in our observations we bring forth an organization as a self-organizing system by

distinguishing it as such (through the recursive connection between language and a constructed reality). As a self-organizing system this organization would be seen to exist as a product of its observer-members recursively generating it through their own acts of self-organization.

To speak of an organization as "it" is to tempt an objectivistic formulation in which an entity is seen to exist apart from an observer bringing it forth in a domain of description. To bring forth such an organization does not imply the creation of a reified entity. Rather, it refers to the recursive processes of bringing forth a consensual domain in which observer-members structurally couple in a manner that brings forth certain coherences. This is a continuously ongoing process through which members undergo ongoing structural adaptations in the course of their interactions with the medium. The organization, over the course of its ontology, is created and continues to be created through the structural co-drift of its members. The organized actions that comprise the organization of the system arise in the domains of discourse and are expressed and maintained through the ongoing conversations in the social milieu of the system. Thus the organization exists as a medium of human activity; its identity arises in the distinctions of its observer-members and continues as a consensual domain.

It exists as a concept in the minds and conversations of its observer-members as a product of human interaction.

It is important to keep in mind that an organization is a dynamic system which is only temporarily manifested in stable structures. Therefore ontogenesis is an ongoing process in which the organization of the organization represents the ongoing coordinations of conduct which arise in conversations. Adaptation depends on effective interactions enabling the continued operation of the system.

In the last section it was argued that pathology arises in systems which are designed on the basis of a limited epistemology. The mechanisms by which this occurs are visible only to those adopting a second-order cybernetic epistemology by which we treat the organization as a system rather than a lineal pattern of objects, and promote an awareness of the recursive connection between what the organization is and the processs through which it is brought forth or enacted. From this perspective we can see how deficient explanations create deficient systems which are reflected in patterns of interaction that lead toward a path of breakdown and disintegration. Pathology, in such instances, can be seen to arise through processes of self-organization persisting in the face of a context which is configured to operate on the basis of instructive interaction and a narrowly defined coherence of trivialization.

While we cannot organize a self-organizing system we can attempt to bring forth an organization on the premise that it and its observer-members are autopoietic systems and that operates on this basis. This is a similar approach to that of Winograd and Flores (1986) who indicate that successful computer systems are designed in alignment with the structure of the domain in which they operate. The determination of what is important to an autopoietic system is tied to the constructivist epistemology through which processes of self-organization and closure are explicable.

The conditions within organizations arise through recursive processes. Therefore when an organization is defined as self-organizing, the distinctions which arise from this definition become part of the medium of the organization. If observers see their organization as an autopoietic/self-organizing system and build it on the premise that, in order to maintain its organization, it must conserve adaptation, a recursive connection between language and reality is set up through which the organization is generated to conserve adaptation. Factors which are deemed important to the conservation of adaptation would be introduced in the network of conversations in the medium of the organization. Fundamentally, since the organization is the interactions of its components (manifested in recurrent conversations), these interactions must be characterized by a wide range

of choices in order to increase the capacity for internal state change. The closure here is evident to the observer who sees that the interactions which represent the organization of the organization describe a way of operating which produces more interactions. Thus the system is defined in terms of the processes that realize it; the organization is a product of these processes and exists to produce them.

While we cannot define a self-organizing system in terms of its features we can identify issues that are important to their operation as self-organizing systems. Since members are observers bringing forth their realities, a second-order cybernetic interpretation requires that we recognize this and create a system which depends on members operating as observers. This would entail creating conditions for the production of a consensuality of agreement rather than conditions which attempt to suppress the operation of its members as observers. The basis of the system would be variety increasing rather than decreasing, and its members would be viewed as resources.

These issues have been addressed by von Foerster (1984). The essence of the difference between bringing forth a traditional organization and one which expresses a constructivist epistemology is represented in the shift between two injunctions, "Thou shalt" and "I shall". In the former case, von Foerster points out, the organization

and the organizer are seen as separate - "it is the world of organizing the other." In the latter case the observer is "included in his organization: it is the world of organizing oneself" (p. 6). What this highlights is that, in effect, organizing the organization is organizing oneself, only at a different level of recursion. Von Foerster concludes that the consequence of this is that "In a self-organizing managerial system each participant is also a manager of this system" (p. 8). This statement is consistent with von Foerster's ethical imperative "Act always so as to increase the number of choices", which itself is a consequence of a constructivist epistemology.

Recognition of the recursive relationship between organizing the organization and organizing oneself emphasizes that the former is dependent on the latter. As Maturana and Varela stressed, social systems depend on the creativity of their members whose growth and social learning within the system are necessary for effective interactions. Hence the adaptability of social systems depends on the conservation of adaptation of its members. While the autopoiesis of the members of the organization, as embedded systems, is subordinated in traditional organizations, in a self-organizing system it is nurtured. This is facilitated when each participant is a manager who is a legitimized part of a system which he brings forth with others.

The last twenty years has seen the emergence of the term "quality of work life" as a concept with many corollaries focussed on the humanizing of work and related conditions (the volume "The Quality of Working Life" by Davis and Cherns, 1975, provides an overview). Without delving into this theory base, and at the risk of superficiality, the imperatives of a constructivist epistemology would appear to fundamentally address the issue of the quality of working lives of people in organizations. A participant who is a legitimized part of a system which he brings forth with others can hardly be disenfranchised. When the viability of the system is seen to be tied to processes of self-organization rather than enforced mechanisms of stabilization the consequence is that individuals have more options and choices. Von Foerster (1984) has indicated that de-trivialization is called for in self-organizing organizations. As non-trivial machines, individuals are able to trivialize their environment rather than be subject to the attempts of others to trivialize them. They are given control over their own lives.

The attenuation of quality of work life can be seen to result from treatment of individuals as allopoietic components of larger systems, not only in terms of their relationship to a larger system distinguished by an observer, but also in terms of their operation as structure determined entities. A second-order cybernetic

perspective allows us to logically account for the difference between the unity as a component of a larger system and its operation in its own domain of existence as an autopoietic system, and indeed when we do this we are able to see the importance of quality of work life. If we do not respect this, and instead treat component unities as trivial machines, they are participating in a consensual domain which limits their ability to continue in their own adaptation. This of course, also limits the adaptability of the larger system, because the consensual domain is characterized by impaired interactions.

Treating each participant as a manager of the system is important to a self-organizing system for another reason. Von Foerster indicates that reality = community, a statement which expresses the consequence of the coexistence of more than one observer each constructing a reality. This arises in a constructivist epistemology where individuals take responsibility for their distinctions and the coherences that arise reflect a multiverse. As Maturana and Varela have stated, we cannot know a world from a point of reference independent of ourselves. When this is recognized it is possible to achieve a consensuality of agreement in which distinctions reflect many observers' relationships to the system.

Von Foerster (1984) indicates that this kind of organization is a "heterarchy", in which different people make decisions at different times. Von Foerster recounts

a story told by Warren McCulloch that demonstrates the significance of this to organizations. It is

> the story of the battle of the Midway Islands where the Japanese fleet was out to destroy the American fleet. Indeed, the American flagship went down in the first few minutes, and its fleet was left to organize itself, i.e., to switch from a hierarchy to a heterarchy. What happened now was that the skipper of each vessel, small or big, took the command over the entire fleet whenever he realized that he, because of his position at that moment, knew best what to do. The result, as we all know, was the destruction of the Japanese fleet, and the turning point for the developments of the war in the Pacific. (p. 8)

While a hierarchy prescribes a narrow range of activity for its members, a heterarchy increases the choices for action. Rather than rigid, limiting roles, each participant is a manager of the system and is involved in the ongoing conversations which lead to coordination of actions and hence is involved in inventing the organization. This could occur with respect to both formal conversations about the design of the organization and its ongoing informal ontogenesis. Heterarchies thus allow for wider choices in the recurrent conversations that comprise the organization of the organization and for

a consensual domain to arise through the involvement of all participants, as opposed to a view from the top.

As a self-organizing system in which coherences arise through structural coupling in language, coordinations of conduct thus depend on the plasticity that is described by non-rigid interactions. A heterarchy is a structure which is in alignment with the operation of participants as observers constructing realities and creating a world with others. As an example of the conservation of adaptation of such systems, Von Foerster (1984) describes the experiments of Alex Bavelas in which the communication process between five individuals was examined under different connectivity arrangements. In order to complete the task, which involved the identification of a common symbol on a deck of cards, the individuals were required to communicate through prescribed channels, in one case a circle and the other a star (where every one communicated through one individual). Under the condition where the symbols were indistinct the star group's performance disintegrated in a state of mutual recrimination, whereas the circle group invented new terms in order to solve the problem. Von Foerster's interpretation of this experiment is an apt description of the kind of processes that can arise in a self-organizing system: "One of the outcomes of the Bavelas experiments suggest that interaction structures can be facilitators or inhibitors for communication. It appears that circulatory, recursive

interaction patterns are highly stable against perturbations. The important point, however, is that this stability is not through counteracting the perturbing forces, but by utilizing them as a wellspring of creation" (p. 22).

While fundamental autopoietic and constructivist themes provide a conceptual impetus to defining congruent organizational distinctions, many manifestions of these themes are possible. For example, the implications of Heinz von Foerster's recommendation, that objectivity be replaced with responsibility (Segal, 1986), are many. We could assess which of the many possible theoretical distinctions fit within the autopoietic framework by comparing them to distinctions that do not fit. Thus, we can try to avoid the generation of negative eigenstates by avoiding the introduction of ontological and epistemological fictions into the theory and praxis of organizations by avoiding distinctions and explanatory principles that do not fit. Fit is determined by looking for pathology (defined through the functional processes of autopoiesis) and steering away from it in a direction roughly charted according to the functional processes of autopoiesis. Contrasting explanatory principles that fit with those that do not can help us define factors that generate the organization, whether pathologically or favorably.

Thus, the exploration of work organizations as autopoietic systems can be approached by analyzing explanatory principles in terms of their fit. Some of these could display aspects which are implicitly congruent even though they may not be explicitly derived from this ontological foundation and thus are not framed in the language of autopoiesis. Others would display beliefs about how organizations function and ubiquitous practices that are wholly at odds with autopoiesis. There are many possible theoretic domains related to work organizations that define different experiential worlds. Sociotechnical Systems is used here as a vehicle to facilitate the explication of some pertinent issues, and on the whole should be relevant to the endeavor of defining work organizations as autopoietic systems.

Sociotechnical Systems

Sociotechnical Systems (STS) Theory is a comprehensive model of organizing developed by F. Emery and E. Trist at the Tavistock Institute during the 1950's (Trist, 1981). This discussion is not focussed on the theory of STS which is very complex and vast. Of primary interest are the STS principles which bear strong similarities to the notions of self-organization, even though the terminologies are largely unique. This is of interest to the present discussion because within the basic STS model of coherence processes of self-organization can be seen (at least to the observer who is

looking for these processes), even though they are not overtly stated in the theoretical distinctions derived from STS that explain the nature of organization.

While the originators of STS theory did not have the benefit of the language of autopoiesis and second-order cybernetics, in many respects an implicit correspondence with them can be distinguished; it is as if there is an unstated expectation that individuals behave as autopoietic systems structurally coupling in language, bringing forth consensual domains, and that a system could not maintain its organization if that were not the case. Thus STS principles show some compatabilities with treating the organization as a system rather than a lineal sequence of events leading to the bottom line. The process of organization of the system is seen as fundamentally important as the STS approach attempts to establish a process that enables the system to operate in a way that allows it to continue to operate. Interestingly, it does this while claiming to be an open systems model.

The following summary of STS theory and principles represents an overview and consolidation from several sources, including Davis (1977), Cherns (1976), and Pasmore and Sherwood (1978). It is not intended to be comprehensive but is included for the convenience of the reader. Occasionally phrases from Davis (source unknown) are quoted verbatim.

Organizations are transforming agencies. This simply means that they do work to achieve objectives. In order to do this they transform inputs into outputs. The inputs are received from outside the organization (or unit), and the outputs are exported outside the organization (or unit). The transformation process is the business of the unit.

The transformation process has both a technical and a social component. a) The technical system consists of tools, machines, equipment, facilities, methods, programs and procedures which are the means by which the people in the organization tranform the inputs. The effective operation of the technical system is the means by which the organization achieves success. Once designed, the technical system is stable, and any disturbances that occur in the technical system itself (or in the environment) have to be dealt with by the people.

b) The social system is made up of the members of the organization and the work-related interactions among the people who operate and maintain the technical system, including roles, jobs, authority structure, communication structure, adaptation mechanisms, learning mechanisms, social system maintenance mechanisms, career structure, and so on.

c) Both social and technical systems are essential to the functioning of the organization (or unit). The technical system defines the tasks to be performed, and the social

system prescribes the ways in which they are performed. Each interacts with the other at every person-machine interface or group-machine-function interface. When social and technical systems are viewed together (ie: in terms of their interaction) the combination is referred to as a sociotechnical system. Joint optimization means that joint optimization of the social and technical system together is more effective than maximizing one and fitting the other one to it. However, this also raises the prospect of degrading either the technical system or the social system in order to achieve a better joint outcome. Organizational effectiveness is achieved by designing for joint optimization.

Guidelines for Design

1) Human Values - Quality of Work Life - organization design focuses on the human dimension as well as the usual technical and economic dimensions. The goal is a high quality relationship between worker and total working environment.

2) Participation in Design and Operation - participation in the design process is essential for those who have the responsibility for achieving successful operations.

3) Organizational Uniqueness - the structure of the organization (or unit) should suit the specific organization's situation and requires individualized design rather than imported or copied solutions.

4) Boundary Location

a) adaptive organizations require self-maintaining units as their basic building blocks that have the capability to perform all the activities required to achieve their objectives under a variety of circumstances.

b) within a unit, those responsible for achieving the outcome have access to and exercise control over the things that go wrong in performing work.

c) members of a unit can develop some autonomy or a substantial degree of control over their own activities in achieving the desired goals of the unit.

d) members of a unit can have access to all the information they need to solve the unit's problems and to assess its performance (feedback).

e) the boundaries are between the main transformation process rather than cutting through a process; they are at the completion of a process, product, or subdivision of the product.

f) the outcome of work activities can be measured at their boundaries in order to provide feedback needed by the unit to regulate itself.

g) coordination between activities and people can be accomplished within the organizational unit, leaving integration to boundary managers.

h) the skills needed to do the work and to maintain the tachnical and social systems of the unit are within the boundary.

i) the need for external control and external coercion is minimized and replaced with self-regulation in achieving desired outcomes.

j) make large small - organizational and physical structures, wherever practicable, should provide smaller and more intimate units.

5) Minimal Critical Specification - what is essential should be identified; no more should be specified than is absolutely essential. This implies the minimal critical specification of tasks, the minimum critical allocation of tasks to the job or of jobs to roles and the specification of objectives with minimum critical specification of methods of obtaining them. The same concept applies to the design process - options should be kept open.

6) Variance Control - variances, if they cannot be eliminated, must be controlled as near to their point of origin as possible. Variance is an unprogrammed event; a key variance is one which critically affects outcome (eg. a deviation in quality of raw materials or equipment parts from suppliers, failure to take action at a critical time, a machine failure, and so on). Much of the work of supervision, inspection and management is the effort to control variance, often by trying to correct its consequences rather than preventing it in the first place. Inspecting the outcome of an activity does not make right what is wrong, and if carried out at a later time by someone else, the correction of the variance becomes a

long loop which is a poor design for learning. The fewer the variances that are exported from the place where they arise, the fewer levels of supervision and control required. Identifying variances and determing key variances often require lengthy analysis. As much as possible, the authority, resources and skills required to detect and correct a variance should all be present within the individual or unit nearest to the occurrance of the variance.

7) Multifunctionalism - wherever practicable each element or unit performs more than one function. This helps prevent requiring people to perform highly specialized, fragmented tasks and adds adaptability. This principle is a major rationale for progression system, rotation, cross-crafting, and the integration of many functions in one organizational unit.

8) Information Flow - information (data, feedback) is provided to those who can take action rather than those who control the actions of others. Information enables organization units or teams to learn to control variances that occur within their sphere of responsibility so they can anticipate events which are likely to affect their performance.

9) Minimal Status Differentials - differences in priviliges and status that are unnecessary to role performance and organizational effectiveness should be minimized, if not eliminated.

Compatability with Self-Organization

STS theory does not describe a second-order cybernetic epistemology. There is no stated recognition of constructivism or the recursive relationship between language and a reality brought forth. There is no distinction that language structures and a belief in objectivity are the basis for pathology in systems. In this respect, STS arose from a first-order cybernetic model with inputs, outputs, feedback systems, and so on, and strictly speaking, coherence is explained in these terms. The step toward second-order cybernetics is more intimated than actually taken. Yet patterns of recursive operations and self-organization are discernable and thus describe conditions of coherence which are compatible with those that could be brought forth from distinctions of self-organization. These conditions include: the treatment of organizational members as full non-trivial participants, the generation of heterarchies, production of consensual domains through recursive interaction patterns, the emergence of a unique organizational state, and the production of a system that operates in a way which allows it to continue to operate. It should become apparent in the following discussion that major elements of STS are process focussed.

From a second-order cybernetic perspective, participation must occur in one form or another so long as

an individual remains structurally coupled to the medium of the organization. Thus organizational members are participants in patterns of dynamic interaction, whether they are characterized by pathology or a consensuality of agreement. Worker participation is a topic which has received considerable attention in the organizational literature, and indeed there is considerable variation in what is seen to constitute a desirable mode of participation. In practice, STS organizations are sometimes seen to be synonymous with various aspects of participation (Pasmore, Francis, Haldeman, and Shani, 1982). This is an important issue with respect to the correspondence between STS and self-organization because the nature of participation in STS has some unique attributes that set it apart from the broad range of concepts that fall under the rubric "participation". This becomes evident when we examine some of the issues related to participation.

Increased worker participation is currently in vogue in Japan, North America, and much of Europe, but has been a topic of discussion among organizational theorists for decades. The "Western Electric" studies by Elton May, W. Lloyd Warner and B.B. Gardner dating from the 1920's initiated much of the impetus for the study of worker participation (Whyte, 1983). However in spite of the interest in participation managers have demonstrated interminable patience with traditional approaches to

organization. According to White (1983) their inattention was due to the contemporary opinions of European and Japanese management that American management techniques were the most effective. With the doting admiration from the Europeans and Japanese the motivation to explore new approaches was negligible. However, interest in and application of self-management in Yugoslavia and Isreal (Warner, 1976), supported the burgeoning popularity of the "human relations" approach among academics in the United States.

Ironically, the Japanese, as part of their post-war effort to emulate American management, adopted the thrust of the human relations literature, mistakenly believing that it reflected the views of American managers (Whyte, 1983). The Japanese also adopted the idea of "quality circles" from W. E. Deming (Deming, 1982), and with development, integrated them with the human relations approach. This resulted in worker participation in decisions around product quality (Munchus, 1983), and rather than the quality of an individual's work being subject to control by a supervisor, it became the responsibility of the worker. While the bulk of quality circle efforts focussed on quality, productivity and safety were also dealt with. The trend toward increased participation and control over one's job has also developed in Scandinavian countries (Gardell, 1977), and

the current level of interest appears to be increasing in North America.

A broad range of terms are used to describe worker participation, including: worker's participation in management, participative management, self-management, power equalization, quality circles, semi-autonomous work groups, autonomous work groups, and participative decision making. Also, several "brand-name" terms exist, such as System 4 (Likert & Likert, 1976), Theory Y (McGregor), and Theory Z (Ouchi, 1979). Faced with the problem of defining the term "participation," Hespe and Wall (1976), in recognizing the broad range of possible variations and forms of participation, offer a general definition: "It refers to the involvement and influence of one group of individuals in decision-making processes which are customarily the prerogative or responsibility of a different group of individuals" (p. 413). In addition, these writers indicate that involvement and influence are on a continuum with complete hierarchical control at one end where management has full responsibility for decision making and non-managerial workers do what they are told. At the other end, non-managerial employees have full decision making authority. Participation occurs anywhere between these two extremes where the decision making process is influenced by both managers and nonmangers. A common thread of different variants of worker participation includes some degree of shift from an

external control focus such that plans, rules, and task coordination are shifted from formal leaders to a lower level of observer-member distinction. The variation in the characterization of this approach extends from mere communication (Scanlon & Atherton, 1981) to the assertion of Hinckley (1985) that "participation is an interactive, not a debriefing process" (p. 57).

Often the nature of the participative arrangements in organizations clearly reflect a kind of circuitous attempt at instructive interaction and an emphasis on output that betrays total absence of any shift from a hierarchical model of coherence. As Dachler and Wilpert (1978) indicate,

> research in the productivity and efficiency tradition limits participatory arrangements in scope and intensity, restricts them to issues surrounding task accomplishment, and characteristically leaves them under the complete control of management, so that there is no intended challenge to the basic power perogatives of business leaders. Participation is seen implicitly as a relatively unimportant way to ensure the stability of the current social and economic order, to increase industrial productively, and to avoid disruptive and costly labour unrest and sabotage. (p. 9)

Similar attitudes toward participation abound in the literature. We are told that participation maintains

predictability and increases organizational control by shifting the control process away from the formal leader to other sources (Mills, 1983), that compliance is more thorough when it is voluntary (Tannenbaum, 1968), and that participation is not "rule by the proletariat" (Tannenbaum et al., 1974). Another limiting effect on self-management is the reluctance of those with authority to relinquish it (Manz & Gioia, 1983). These reluctant power holders have numerous allies in the literature. In informing us of some difficulties with participation, we are advised by Kanter (1983) that careful management control is needed. Scanlon and Atherton (1981) indicate that it is up to the discretion of managers when to use participative principles and when not to. Obviously this implies very low level participation that is under complete management control. This is still control, but is the control of participation, a second-order control which is synonymous with the control of control.

A second-order cybernetic view suggests that the nature of participation in an organization depends on the "theory-in-use" of the observers who are generating the design of the organization. Dachler & Wilpert (1978) indicate that one dimension of participation "refers to the social theories underlying participation which represents the basis for the values and assumptions of the designers and implementers of participatory social

arrangements in organizations as well as the goals and objectives in participation" (p. 3).

They list four of these including: Democratic theory, Socialistic theory, Human growth and Development theory, and Productivity and efficiency orientation. It is not difficult to imagine that participation based on these different rationales would have different control characteristics regarding organizational coherence.

As previously discussed, STS does not explicitly define coherences as arising out of processes of self-organization. But it does make distinctions which typically reduce or eliminate references to hierarchy, encourage consensual decision making processes involving impacted parties, limit perturbations in the medium delivered in an instructive format, attempt to respect the needs of employees, provide ample opportunity for dynamic interaction within a minimally constrained medium, and generally create conditions of rich structural coupling.

An aspect of STS that is unique relates to the coherence which is defined through the totality of the principles which guide the design of an organization. Participant involvement in many organizations occurs through the use of "parallel structures" (Mansell, 1987) such as task forces, joint union-management committees, quality circles, and the like. "Parallel structures" exist in parallel to, or outside, the basic management system of the organization, and thus do not interfere with

the basic operation of the system. A STS designed organization, on the other hand, produces a fundamentally different kind of organization, including basic management structures, work design, and support structures. Certain features and arrangements are integrated into the organization's daily operation. Participation in parallel structures thus offers no challenge to a traditional model of coherence, whereas, to the extent that structural changes affect processes of self-organization, participation in STS could be seen to define a different coherence. This raises the interesting prospect that the mode of coherence is structure determined.

Within the structure of semi-autonomous work groups, individuals and teams generally have full discretion to carry out the mandates of their groups. This is supported by the principle of minimal critical specification which gives maximum choice to work groups regarding the operation and design of their unit. The maximization of choices has also been termed "requisite response capability", indicating that all organizational units and individuals have the ability, resources, and authority to meet the variety of circumstances which might arise. Choice is also increased by minimizing rules and regulations. Trist (1981) points out that the gain in flexibility can also be used to accomodate personal needs.

Coherence under such conditions can be seen to be brought forth dynamically from the involvement of

participants in patterns of recursive interactions giving rise to coordinated actions. These are participant defined and able to change in response to perturbations. Adaptability is served because the organization is designed to produce processes which sustain the response capability of its units. In STS there is considerable emphasis placed on the fact that the organization is always in a process of design and redesign.

Recursive operations are evident in the concept of "compatability", which holds that the process of designing the organization must reiterate the processes which define its operation. This means that the organization must be designed through participative processes involving conversations among all stakeholders. We could say that a process produces a product which is the process that produced it. The significance of this is that workers define the jobs and organizations that define the workers. Thus their identities are expressed in the identity of the organization because they are creating it in community with others. Also the organization is designed as a multiverse and thus is unlikely to reflect a narrow model of hierarchical coherence based on the view of observers from the top. It is therefore more likely to describe a consensuality of agreement.

STS theory maintains that the design process allows different organizations to be invented, based on the particular circumstances at hand. Within the general

guideline of STS principles (which in many cases are process oriented) a number of possible organizational configurations and features are possible. This recognizes that each organization is unique and, from our second-order cybernetic perspective, we can see that this uniqueness is due to each organization's manifestation of its own eigenstate which is experienced as a stable identity.

Thus participation in design in an organization invented on the premise that it is a sociotechnical system, is what allows us to see its operation as a self-organizing system, even though it is not brought forth from a constructivist epistemology. It is probably reasonable to suggest that the STS description of participation in design qualifies the participant as a manager of the system in the sense of von Foerster's (1984) statement that "In a self-organizing managerial system each participant is also a manager of this system" (p. 8). Indeed participation in design is seen by most STS theorists to be critical; to define an organization just in terms of common features of other STS organizations and have it unilaterally introduced by management is seen as insufficient (e.g. Gustavson, 1988), although the primacy of processes of self-organization is not given as the reason.

While STS theory does not express a second-order cybernetic epistemology, it does seem to bring forth

interaction structures that set an appropriate context for processes of self-organization. Violations of a constructivist epistemology by observers operating within such a context might be less frequent if this epistemology were part of the recurrent conversations in the medium. But on the other hand Varela has indicated that even in subject areas where the new models of living systems are familiar, the basic ideas (e.g., the environment contains no information, cognizing systems are operationally closed, objectivity is not a condition of independent descriptions) are not adhered to.

It is debatable whether or not organizational members can continuously operate with objectivity in parentheses. However organizations can still be brought forth on the premise that they are self-organizing systems so that, rather than building deficiencies into the system we can set a context for dialogue and effective interaction that facilitates coordination of conduct in a consensuality of agreement. If this is what organizations do that are brought forth as sociotechnical systems, then the language of self-organization represents an expansion of STS theory. From our constructivist epistemology we might see STS as a latent second-order cybernetic notion disguised in first-order cybernetic terminology.

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